The SCIENTIFIC MONTHLY

VOL. LXVI *May 1948* NO. 5

Photograph by the Library of Congre[ss]

ANNEX BUILDING, LIBRARY OF CONGRESS

BOOKS ON SCIENCE AND TECHNOLOGY ARE STORED HERE (*see* page 405).

PUBLISHED BY
THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

An entire season of baseball action—from Opening Day to World Series—is yours with RCA Victor television.

You're right in the game—with Television

Comes the shout "Play Ball!" and there you are—on top of every play.

Through television developments in RCA Laboratories, all the action is yours—the crack of bat against ball—every step of fast infield plays—even sidelights in bull pen, dugout, grandstand and bleachers.

At the ball park, RCA Image Orthicon television cameras—rivalling the human eye in sensitivity of "vision"—get all the action in day or night games. Shifts from over-all views of the field, to "close-ups," are swift and revealing . . .

And at the *receiving end*—your RCA Victor "Eye Witness" home television set gives you brighter, clearer pictures. You can see the ball that the batter misses, or you can watch his home-run sail over the fence.

Today, because of the original and continuing work of RCA scientists, millions can enjoy sports, entertainment, educational and news events, on television. Research at RCA Laboratories—always a "step ahead"—enters every instrument marked RCA or RCA Victor.

When in Radio City, New York, be sure to see the radio, television and electronic wonders at RCA Exhibition Hall, 36 West 49th Street. Free admission. Radio Corporation of America, RCA Building, Radio City, N.Y. 20.

RCA

RADIO CORPORATION of AMERICA

THE SCIENTIFIC MONTHLY

VOL. LXVI — MAY 1948 — NO. 5

F. L. Campbell, *Editor* — Gladys M. Keener, *Assistant Editor*

Theo. J. Christensen, *Advertising Manager*

Annual Book Issue

Centennial Celebration, A.A.A.S., Washington, September 13–17, 1948

Published monthly at Business Press, Inc., by the American Association for the Advancement of Science under the direction of the Publications Committee: Farrington Daniels, J. E. Flynn, Kirtley F. Mather, Walter R. Miles, Malcolm H. Soule, and Steven M. Spencer. Office of publication, North Queen St. and McGovern Ave., Lancaster, Pa.

Orders for subscriptions and requests for change of address should be directed to the Circulation Department, A.A.A.S., N. Queen St. and McGovern Ave., Lancaster, Pa., or 1515 Massachusetts Ave., N.W., Washington 5, D. C. Four weeks are required to effect changes of address. Address all correspondence concerning editorial matters and advertising to the Office of The Scientific Monthly, 1515 Massachusetts Ave., N.W., Washington 5, D. C. Subscriptions: $7.50 per year; single numbers, 75 cents. Entered as second-class matter at the Post Office at Lancaster, Pa., December 30, 1947, under the Act of March 3, 1879. Acceptance for mailing at the special rate of postage provided for in the Act of February 28, 1925, embodied in paragraph 4, Sec. 538, P. L. and R., authorized December 30, 1947.

THE SCIENTIFIC MONTHLY

MAY 1948

THE NOBEL PRIZES*

HERMAN ERIKSSON

A native of Upsala, Sweden, Mr. Eriksson received his B.A. in government and administration at the University of Stockholm in 1919. In 1932, he was made Permanent Undersecretary in the Swedish Ministry of Finance and remained in that capacity until 1936, when he became President of the Board of Trade. He was Minister without Portfolio in 1938; Minister of Supply, 1939–41; and Minister of Commerce, 1941–44. He became Swedish Minister to the United States in 1945 and Ambassador in 1947.

TO SWEDEN the provisions of the last will and testament of Alfred Bernhard Nobel—the native-born scientist, inventor, and industrialist—came as a complete surprise. Never before had such a fortune been amassed by an individual Swede, nor had one ever been devoted to such idealistic and wholly international purposes. That Sweden had been chosen to administer the fund, which had been built up almost entirely outside the country, was naturally considered an exceptional honor, especially as it came from a citizen who had spent almost his whole life abroad. Obviously, the honor also involved many obligations and heavy responsibilities. Each year the award of the Nobel prizes would center the attention of the world on Stockholm.

On December 10, 1896, at the age of sixty-three, the frail-bodied but mentally alert inventor of dynamite and other high explosives died in his winter home at San Remo in northern Italy, and on December 31 of the same year the contents of his will were announced. It had been signed in Paris on November 27, 1895, and had been written out in Nobel's own hand. In form it was so unprofessional that manifestly no lawyer had been engaged in the composition, and yet its purpose was perfectly clear. The witnesses were employees of the testator in France, and the two executors named were Swedish engineers also employed by him. The younger of these, Ragnar Sohlman, then but twenty-six years old, is still living today. To him and a colleague was entrusted the settlement of perhaps the largest private estate in Europe up to that time. After debts and personal legacies had been paid, it amounted to about 33,125,000 kronor, or roughly $9,000,000 at present rate of exchange. As the property was located in many different countries and the money had been invested in various kinds of securities, it took some time to settle the estate. The will was contested by some of the Nobel relatives in Sweden, but a compromise was soon reached. The final sum available for investment in "safe securities," as directed by the will, was about 31,125,000 kronor, or nearly $8,000,000.

* All photographs by courtesy of the American-Swedish News Exchange, Inc., New York, N. Y.

As only the income from this residuary fund was to be distributed each year in the form of five prizes, the amount of the main fund has been kept fairly constant. In 1936, for example, it was 32,600,000 kronor; the special funds set up for testing laboratories, libraries, etc., brought the capital sum up to 48,860,000 kronor. The cost of special buildings was about 2,330,000 kronor, which raised the total assets to nearly 50,000,000 kronor, or roughly $14,000,000.

Since the prize amounts depend on the income received from the securities in which the main fund is invested, the monetary value of the prizes varies from year to year, usually being between $30,000 and $40,000. Since the depression of the early 1930s the figure has usually been around the lower amount. In 1947, however, the income from the fund was declared for the first time to be tax-exempt, and consequently the value of the prizes for that year became nearly $40,000 each. In most countries it is an accepted fact that the civic and professional distinction of a Nobel prize is worth more than the money involved, though the two are necessarily incommensurable. No other prizes in the world have brought such fame. Throughout his life, whenever a winner appears in public or has his name printed in a newspaper or program anywhere in the world, the title "Nobel Prize Winner" is always attached.

Who, then, was Alfred Bernhard Nobel? How did he make his fortune, and why did he devote it to such idealistic purposes?

In ancestry he was wholly Swedish. Surmises that, because of his name, he must have been of at least partly English descent are unfounded. The origin of the name is Latin and not English. His earliest identifiable ancestor was a farm youth from the province of Skåne in southern Sweden, who, because of his intellectual gifts, was provided with an academic education. The name of this ancestor was originally "Peter Olofsson," but because such traditional patronymics caused confusion outside Sweden, the youth was renamed "Petrus Olai Nobelius" when, in 1655 or thereabouts, he entered the University of Upsala, then the only one in the country. The word "Nobelius" had been derived from the name of the young man's birthplace, the parish of East Nöbellöf. This procedure was customary and corresponds to the latinization of personal names on modern American college or university diplomas. A grandson of the first Nobelius, Immanuel, changed the name to "Nobel," with accent on the last syllable. For a while he had to serve in the Swedish army as a noncommissioned officer, where only surnames of not more than two syllables were permitted for men below officer's rank. Ultimately, Immanuel Nobel became a barber-surgeon. (His father had been an instructor in drawing.) Normally, the first Nobelius, being a farm youth, would have studied theology and become a clergyman. Instead he chose the law and at an early age became a judge. He also had a gift for music. In his career he was aided by the fact that he had married the daughter of Olof Rudbeck, perhaps the most learned and most influential professor at the University. All contemporary knowledge seemed to be his field, and the Swedish biographers of Alfred Nobel like to believe that some of the latter's brilliance may have been inherited from this famous ancestor.

His own father, also called Immanuel Nobel, and born in 1801, was the son of the barber-surgeon, who in his early years had gone to sea. There was a definite spirit of adventure in the family, and Immanuel Nobel had inherited his share of this spirit. He was, besides, a man of imagination, an inventor of sorts, an engineer, and a builder in Stockholm, who overextended himself and suffered bankruptcy while his children were still young. From him Alfred Nobel inherited the ferment of genius, the imagination and restless spirit of a dreamer and inventor; from his mother he derived the common sense, the stability, and the practical turn of mind that is a more usual Swedish characteristic. Her three oldest sons became famous as engineers, promoters, and industrialists. While Alfred Nobel became a pioneer in the manufacture of high explosives, from which he derived his fortune, his brothers built up the oil refineries of southern Russia, and until the revolution of 1917 they were

rated among the wealthiest men in Europe. In the oil business Alfred Nobel participated only as an investor and financial adviser.

When Immanuel Nobel became bankrupt in 1842, he first moved to Finland to repair his fortunes, only to fail again. He next went to Russia, where he found greater opportunities to apply his engineering ideas. It is interesting to speculate upon what would have happened had he come instead to the United States, whither his countrymen were then beginning to emigrate. Among the first ideas he launched in Russia was that of submarine mines for coastal defense, and when the Crimean War broke out he received large Russian government orders. He was thus able to build a foundry and a machine shop of fairly large size. In his war work he became associated with N. J. Putiloff, one of the leading Russian industrialists of the day. Nobel had the ideas and the "know-how," and the Russian had the capital and the contacts. Out of this association grew the famous Putiloff munitions works near St. Petersburg, or Leningrad, as the former capital is now called. Having become acquainted through his war work and inventions with the Russian Emperor, Nicholas I, himself and believing he had received his promise and that of his ministers that in the future, too, the Russian government would continue to buy his products, Immanuel Nobel built more and more factories—on borrowed capital. When the war was over and the emperor had died, he discovered that he had been mistaken. The new emperor and his advisers, like new Pharaohs, did not know Joseph or what he had done for Egypt. Once more Immanuel Nobel became a bankrupt and, brokenhearted, he returned with his wife to Stockholm, leaving Alfred and his two older brothers in Russia. Among the new ideas he then worked on was that of combining thin slices of wood, or even shavings, placed crosswise, so as to make firm boards. Out of this conception, modern plywood was ultimately evolved, but he derived no benefit from his scheme.

Soon after settling in Russia early in the 1840s, Immanuel brought over his family and

ALFRED NOBEL, 1833–96

THE DONOR OF THE NOBEL PRIZES.

thus interrupted the schooling of his sons. At the age of eight, Alfred had attended with his brothers a private school in Stockholm (there were then hardly any public ones), but was able to remain for only two terms before being taken to St. Petersburg. This was to be the only formal schooling he ever received. In the Russian capital there were not even private schools that suited the recently arrived young Swedes, so a private tutor was imported for them from Stockholm. In time he was succeeded by a Russian. Both must have done their work well, for all the sons of Immanuel Nobel became in time highly educated men. Alfred Nobel not only was an eminent scientist and inventor; he read and spoke and wrote with almost equal ease Swedish and Russian, German, French, English, and Italian. In all these languages he carried on a regular correspondence, writing, on the average, about thirty letters a day, all in his own hand. Many of them are still preserved in the Nobel Institute in Stockholm. He never had a stenographer or personal secretary. Otherwise, his

policy was to engage experts to do everything that he did not have to do himself, especially if they could do it better.

As early as 1850, when he was only seventeen years old, Nobel was sent alone by his father on a foreign tour. He covered not only Germany, France, and England, but also the United States, a country few Europeans then considered worth visiting. Unfortunately, he kept no diary or any systematic record of his travels. From a letter to a relative, it has been learned that in New York he met Captain John Ericsson, of Civil War *Monitor* fame. Ericsson had arrived from London in 1839, and, thanks to his various inventions, he was by 1850 the most famous Swede in America—except, of course, Jenny Lind. Alfred Nobel does not seem to have known Jenny Lind. Music was not among his hobbies; for composers and singers he established no awards.

In the course of his early studies, Nobel had become interested in explosives, particularly the newly discovered nitroglycerin, or "blasting oil," which an Italian professor, Ascanio Sobrero, had discovered in 1847 in his laboratories at the University of Turin. What to do with it, no one knew. At high temperatures it caused violent explosions, but no one had any idea how to ignite it at the right moment, even when it was cold. It could not be safely transported, and all over the world it began to cause catastrophes, sinking ships and killing men. To ignite the violent liquid at any temperature, Nobel first devised the mercury percussion cap. He had found that not only a spark, but also a shock, was required. Once, in New York, a can of nitroglycerin had been left by a careless salesman in a hotel lobby. When it exploded, some weeks later, not only the hotel but most of the block went up. The whole of lower Manhattan was shaken. From Panama, San Francisco, and many other scattered points came reports of similar disasters. Nitroglycerin was sometimes used by the anarchists of the day in their bombs, and in general it caused much the same anxiety as the atomic bomb has done in recent years.

When Nobel came to New York again in 1865 to form a company for the exploitation of his patents, he found it difficult to get lodgings. By the public he was looked on with a terror comparable to that which would be evoked today by the arrival from Europe of a bewhiskered stranger carrying in his satchel or brief case an atomic bomb or two. For the benefit of the press and a few invited guests, who remained at a discreet distance, Nobel himself demonstrated his new percussion cap by setting off a few blasts in an abandoned quarry in the Yorkville section of upper Manhattan.

During his early experiments in Russia, in the summer of 1862, he had shown his two older brothers that his new cap would cause nitroglycerin to explode even under water. In 1863 he returned to Stockholm and with his father's aid continued his experiments, even beginning to manufacture the new explosive on a commercial scale. Among his first customers were Swedish mine owners and the Swedish State Railways, then under construction. The capital stock of the first Nitro-Glycerine Company was only 25,000 kronor, or about $6,000.

In the autumn of 1864 the new plant blew up, killing five employees, including Nobel's youngest brother, Emil, who was then a university student working during his vacation. This tragedy caused the father to suffer a shock from which he never completely recovered. What error had been committed could not be determined, as only a few splinters were left. But Alfred Nobel did not despair, even though he was forced to set up his new plant outside the city limits and, provisionally, on a barge that could be towed off to a safe distance. Among his financial backers was J. W. Smitt, a wealthy Swede who had become known as the "Swedish Brandy King." The first foreign patent was sold to Norway outright for 20,000 kronor in cash. In all other cases, however, Nobel retained a part interest in foreign companies.

In 1865 he founded his first enterprise abroad, Nobel & Company, in Hamburg, Germany. There he built a factory and moved to Germany himself to supervise his new business. The same year he obtained

THE BUILDING OF THE NOBEL FOUNDATION IN STOCKHOLM

his first American patent and was immediately sued by an American financial adventurer named Shaffner, who had visited him in Stockholm to try to find out how nitroglycerin could be used. Without too much difficulty, Nobel won the suit and then formed The United States Blasting Oil Company to handle his American business. On many other occasions he had to use legal means to protect his rights, since attempts at infringements were frequent, particularly after he had discovered in 1866–67 a way to make the new explosive safe by mixing it with kieselguhr, an infusorial silicate, which he found in Germany. Legend has it that he hit on this idea by observing how the dangerous liquid had solidified upon being absorbed in the sawdust in which a leaky container had been packed, but this cannot be proved.

In the technique of blasting, the discovery of dynamite caused a world-wide change. In 1871 Nobel formed a company in England and soon afterwards, one in France. In both countries dynamite factories were set up and

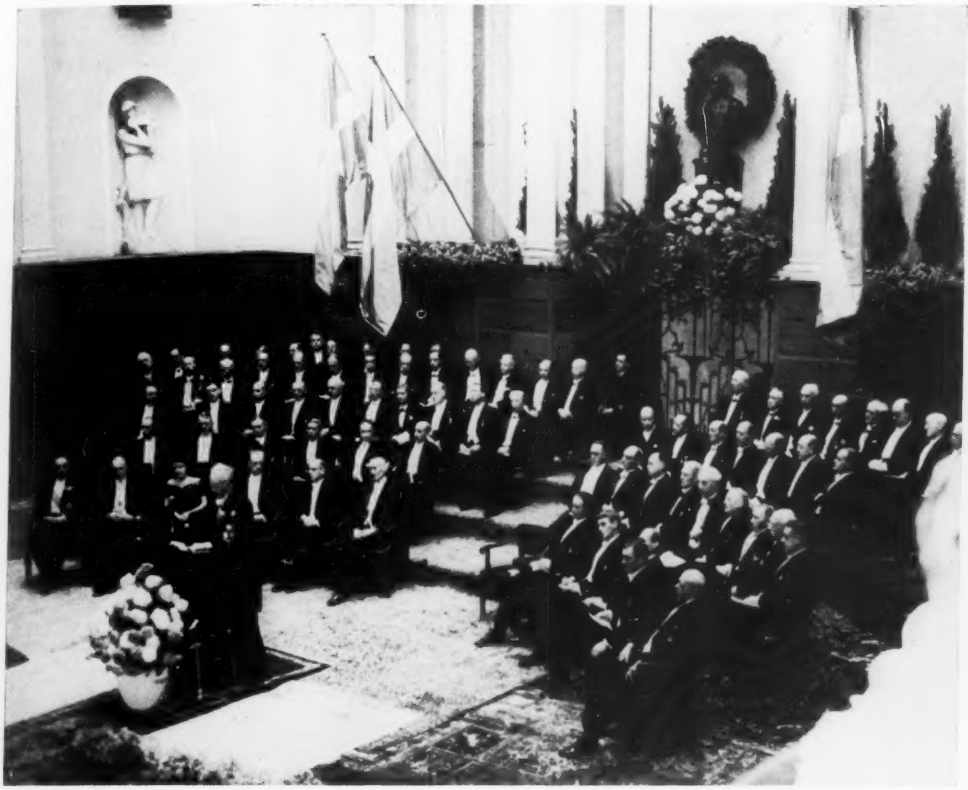
soon began to enjoy a tremendous business. A plant built at Ardeer, in Scotland, was capable of supplying one-tenth of the world's needs. At Pressburg, in Austria, still another factory was built.

After the early 1870s, Nobel had his main residence in Paris, where he acquired a private house near the Arc de Triomphe. In Sevran-Livry, a Paris suburb, he had a private laboratory and there he evolved one improvement in explosives after another. In 1875 he launched his blasting gelatin, a colloidal solution of nitrocellulose, or guncotton, in nitroglycerin. The use of kieselguhr had made the blasting oil safe to handle, but it had also reduced its explosive power. Another of the Nobel legends relates that he thought of the new mixture after applying collodion to a cut in a finger. As he lay awake in the night suffering from the pain in his finger, it occurred to him that collodion, which was a nitrocellulose with a lower nitration, might absorb the nitroglycerin better than ordinary guncotton. At four o'clock in the morning he went to his laboratory to try out the idea, and when his assistants arrived after breakfast he was able to show them the first sample of the new blasting gelatin. This was another step forward in the production of high explosives. His next move was to develop a smokeless powder, which obviously was of great military significance. This new mixture he called "ballistite"; it was patented in 1887–88. It contained approximately equal parts of nitroglycerin and nitrocellulose, with a 10 percent addition of camphor.

The first government to buy the new powder was the Italian. This caused so much resentment in France that Nobel's private laboratory was closed by the authorities. He then moved to San Remo on the Italian Riviera, where he had a winter residence.

In England two scientists, members of an official Explosives Commission to which Nobel had submitted samples of his smokeless powder, with specifications, evolved another mixture that was only slightly different,

AN EXAMPLE OF A NOBEL PRIZE DIPLOMA AND MEDAL



CEREMONY AT THE STOCKHOLM CONCERT HOUSE

THE NOBEL PRIZES FOR 1947 ARE BEING AWARDED, DECEMBER 10, 1947.

which they called "cordite," the patents being assigned to the British government. To settle the question of patent rights, the English Nobel Company brought a friendly court action which, on slight technical grounds, was decided in 1894 in favor of the British. "I wish I had been able to reach a conclusion by which it would have been impossible to deprive Mr. Nobel of the value of a most important patent," wrote Lord Justice Kay, a member of the Court of Appeals.

Although the financial loss was not fatal to Nobel, he resented bitterly what he regarded as a rank injustice. To relieve his feelings he composed in English a play called "The Patent Bacillus," in which he satirized British court procedure and legal logic. It might have served as the libretto for a new Gilbert and Sullivan comic opera, though less soothing than some of them to British self-esteem. Of his achievements as an inventor Nobel was always proud, cynical though he often pretended to be in other respects.

The same year, 1894, he bought a controlling interest in a Swedish concern, the Bofors-Gullspång Company, which he started to expand for the manufacture not only of his new smokeless powder, but also of other munitions and various industrial products for which he had ambitious ideas. He even had an old manor house renovated and partly rebuilt as a summer residence, and a new laboratory prepared for experiments on a large, industrial scale. By that time he had no less than 355 patents in different countries, and from his records it is clear that he had begun to experiment with rocket projectiles and aerial torpedoes. He also worked with an artificial rubber (finally developed in the United States during World War II), and

THE AMERICAN PRIZE WINNERS FOR 1947

DR. CARL F. CORI AND HIS WIFE, DR. GERTY T. CORI, AT THE BANQUET IN STOCKHOLM CITY HALL FOLLOWING THE PRIZE AWARDS. THEY SHARED THE PRIZE IN MEDICINE WITH DR. B. A. HOUSSAY, OF BUENOS AIRES, ARGENTINA. THE CORIS WERE HONORED FOR DETERMINING THE PROCESS BY WHICH THE BODY STORES SUGAR IN THE LIVER AS GLYCOGEN AND THEN RECONVERTS THE GLYCOGEN TO SUGAR AS IT IS NEEDED.

with an artificial silk that was later perfected by others as rayon. His death cut short all these projects. As late as December 7, 1896, he had written in his own hand a letter to Mr. Sohlman, who was then in charge at Bofors, in which he commented on some samples of powder he had just received. "Unfortunately, I am again so poorly that I find it difficult to write these few lines," he scribbled, "but as soon as I can I shall return to the matter that interests us. Your Sincere Friend, A. Nobel." That was his last letter. In a few hours he suffered a stroke and three days later he died.

From his writings and the recollections of his friends and associates, it clearly appears that Nobel's was a complex and unusual personality. In a sense he epitomized the whole nineteenth century. Though he had had but little formal education (he had never graduated from any school or academy), he was a remarkable linguist and an omnivorous reader. Most of his mature years he spent in travel, usually to attend to the interests of his various industrial enterprises. He also had a very wide circle of acquaintances among the leading personalities of his day. Yet he himself was shy, avoiding publicity or public appearances as something improper. Once, when he was asked for his picture to be used in a magazine, he replied: "In these times of pompous and shameless advertising, only those persons who are specially qualified for it should allow their photographs to ap-

pear in print." He felt the same way about decorations. "One cannot refuse to accept them," he once wrote, "without being considered eccentric. But they make one feel embarrassed and are therefore undesirable." "I owe my Swedish Order of the North Star to my cook, whose skill won the approval of an eminent stomach," he wrote at another time. "As for medals," he went on, "I possess a gold medal presented by the Swedish Academy of Science. I am also a member of this academy, and set more store by this distinction than by the various Orders." In 1893 he accepted, however, an honorary doctorate from the ancient Swedish University of Upsala, which he had never attended.

> It would almost be a pity [he then wrote to one of his assistants] if I were to "shake off this mortal coil" now, because I have some particularly interesting things in hand. But since these fellows have made me a Doctor of Philosophy, I have become almost more of a philosopher than before. . . . My natural inclination [he wrote on another occasion] is less to honor the dead, who feel nothing, and who must be indifferent to marble monuments, than to help the living.

Superficially, Nobel may be considered to have been a man of contradictions. His profession of atheism was, however, but a cover for a deep-rooted idealism. "Our religious views differ possibly more in form than in substance," he wrote to the pastor of the Swedish church in Paris, to whom he had just sent a contribution twice as large as the sum requested, "for we are both agreed that we should treat our neighbor as we would be treated by him."

Being endowed with an unusual intellect, and feeling in need of human affection, he suffered from a loneliness that sometimes bordered on melancholia. He was deeply devoted to his mother, who lived until 1889. He nearly always managed to spend Christmas with her in Stockholm. He also knew, and carried on correspondence with, many women, usually brilliant ones, but he remained a consistent bachelor. Through an advertisement for a housekeeper, "to be the hostess of his Paris home," he became acquainted with Bertha von Suttner, a young Austrian noblewoman, who had been

KING GUSTAF AND MRS. CORI

thwarted in love. In the advertisement he had described himself as "an elderly well-to-do person"; actually, he was just over forty. She came to Paris, but before assuming her new duties returned to Austria—and matrimony. Toward the end of his life he resumed correspondence with her, and she may have inspired his endowment of the annual Peace Prize.

Not only was Nobel personally generous with his money during his lifetime, he also provided his mother with enough funds to enable her to exercise an extensive charity. After his death the letters he had received were found tied up in bundles labeled "letters from men," "letters from women," and "letters from beggars."

> Not a day passes [he once wrote] without the post bringing me at least two dozen such requests for help, averaging about twenty thousand crowns; enough to demoralize even J. Gould, Vanderbilt, and Rothschild. . . . Although my income is considerable, I have been forced in each of the two last years, to supplement it with a million francs taken from my capital. One can go on like this for a time, but not forever.

His frail health had often forced him to spend much time at various watering places

AWARD FROM THE KING

KING GUSTAF DELIVERS A 1947 NOBEL PRIZE TO SIR EDWARD V. APPLETON, WINNER IN PHYSICS.

and other health resorts. His extensive travels and his irregular life did not help matters. When he was absorbed in testing a new idea he often forgot his meals. His interest in medicine and physiological problems, which caused him to endow the prize for new discoveries in those fields, was lifelong. At one time he planned to finance a series of medical investigations, "directed toward ascertaining by means of experiments the nature of physical processes connected with disease, and, above all, toward discovering by the experimental method means for the curing of diseases," to quote one biographer. He often stated that he was considering the founding of an institute for experimental medical research, but he never found time to carry out the plan. Sometimes he hinted that medical theories might be a hindrance and that a person free from them might be able to get at the heart of a problem all the more readily.

That was the pragmatic way he worked in physics and chemistry, and often he hit on practical ideas that became revolutionary. At the same time, he appreciated the facts discovered by professional scientists, and his endowment of prizes to encourage them was not surprising, nor that he selected the Swedish Academy of Science, his membership in which he so highly treasured, to nominate the laureates. On the whole, the selections so far have been endorsed by an informed world opinion.

In Nobel's time the so-called social sciences were poorly developed. He left no prizes to economists, sociologists, or political scientists. His interest in human relations, however, was often manifested. He believed in education and that science could ultimately make men not only wise but happy.

To disseminate enlightenment is to disseminate prosperity [he wrote]. I mean general prosperity and not individual wealth—and with the attainment of prosperity disappears the greater part of the evil which is our heritage from darker times. The triumphs of scientific research and the ever increasing field which is coming under its sway give us reason to believe that the microbes of the soul as well as those of the body will soon be exterminated, and that the only kind of war which humanity will wage in the future will be war against these microbes.

When he saw how his discoveries, which he had hoped would be used to promote civilization and reduce human drudgery, were being turned more and more toward military purposes and pure destruction, he naturally brooded over the problems of peace and war. To Bertha von Suttner he said at Zurich in 1892, "My factories may end war sooner than your [peace] congresses. The day when two army corps will be able to destroy each other in one second, all civilized nations will recoil from war in horror and disband their armies." He did not foresee how few nations were to prove themselves "civilized" when external danger threatened; nor the growing strength of nationalism, the spirit of which has been capitalized by warmakers.

I am beginning to believe [he wrote in October 1892 to a friend in Belgium] that the only true solution would be a convention under which all governments would bind themselves to defend collectively any country that was attacked. Such a treaty might lead gradually to partial disarmament, which is indeed the only kind of disarmament possible, for it is necessary that there should be an armed force to maintain order. In former days, governments used

to be more narrow-minded and clamorous than their subjects; but nowadays it seems as though the governments were endeavoring to tranquilize the idiotic passions of a public that is aroused by pernicious newspapers.

About the methods by which "pernicious" newspapers can be utilized by governments to serve their purposes much has been learned since Nobel's day. The convention he favored was roughly in the Covenant of the League of Nations, but that, too, failed. Now we are trying the idea once more in the United Nations. The annual Nobel Peace Prize, for which the candidates are selected by a Norwegian Parliamentary Committee, serves as a stimulus to serious thinking about a problem that half a century or more ago was close to the heart of Nobel. That he established the Peace Prize as a salve to his conscience for having invented high explosives cannot be demonstrated. Improved weapons have never been the cause of war; on the contrary, the atomic bomb may achieve the very results that Nobel hoped his dynamite, explosive gelatin, and ballistite would bring about.

I should like [he wrote Bertha von Suttner in

NOBEL PRIZE WINNERS SIR EDWARD APPLETON AND HAROLD C. UREY

SIR EDWARD APPLETON (*right*) IS SECRETARY OF THE DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH, LONDON. PROFESSOR UREY, NOW AT THE UNIVERSITY OF CHICAGO, WAS THE 1934 WINNER IN CHEMISTRY.

DR. B. A. HOUSSAY

HE SHARED THE 1947 NOBEL PRIZE IN MEDICINE AND PHYSIOLOGY WITH DR. AND MRS. CORI.

January 1893] to make use of part of my fortune for the establishment of a prize fund, to be distributed in every period of five years (we may say six times, for if we have failed at the end of thirty years in reforming the present system, we shall inevitably revert to barbarism). This prize would be awarded to the man or woman who had done the most to advance the general idea of peace in Europe. I do not refer in this sense to disarmament, which can be achieved only by slow degrees. I do not necessarily refer even to compulsory arbitration between the nations; but we should soon achieve the result (and it can be done) that all states bind themselves absolutely to take action against the first aggressor. Wars will then become impossible, and we should succeed in compelling even the most quarrelsome state, either to have recourse to a tribunal or to remain quiet. If the Triple Alliance [Germany, Austria, and Italy] instead of comprising three states were to secure the adherence of all, peace would be ensured to the world for centuries.

Such was his dream two generations ago. That even shreds of civilization could survive two world wars would probably have surprised and, in a way, encouraged him.

Nobel's interest in literature, primarily poetry and drama, though he also both read and tried to write fiction, dated from his early youth. Much of his political radicalism, or at least his aversion to the personal autocracy and dictatorship represented by the Russian czars, he must have absorbed from his early reading of some of the great Russian novelists. His favorite author and the one who influenced his mind most, both politically and aesthetically, was the English poet Percy Bysshe Shelley. The verse he wrote himself (and later burned) was usually in English. He made it clear by various remarks that, just as he intended to encourage young scientists to continue their research, he wanted to help young writers who had something to say for the benefit of mankind. In his will he expressly stated that the Literary Prize should be given for "the most distinguished work of an idealistic tendency." Clearly, he did not favor either satire or hard-boiled fiction.

WHEN he sat down in Paris in the fall of 1895 to formulate in his Last Will and Testament the ideas he had entertained for years, he wrote as follows:

I the undersigned Alfred Bernhard Nobel hereby declare after mature consideration that my last Will with regard to the property which I may leave on my death is as follows:

With the residue of my convertible estate I hereby direct my Executors to proceed as follows: They shall convert my said residue of property into money, which they shall then invest in safe securities; the capital thus secured shall constitute a fund, the interest accruing from which shall be annually awarded in prizes to those persons who shall have contributed most materially to the benefit of mankind during the year immediately preceding. The said interest shall be divided into five equal amounts, to be apportioned as follows: One share to the person who shall have made the most important discovery or invention in the domain of Physics; one share to the person who shall have made the most important Chemical discovery or improvement; one share to the person who shall have made the most important discovery in the domain of Physiology or Medicine; one share to the person who shall have produced in the field of Literature the most distinguished work of an idealistic tendency; and, finally, one share to the person who shall have done most to promote the Fraternity of Nations and the Abolition or Diminution of Standing Armies and the Formation and Increase of Peace Congresses. The prizes for Physics and Chemistry shall be awarded by the Swedish Academy of Science [Svenska Vetenskapsakademien] in

Stockholm; that for Physiology or Medicine by the Carolinian Medico-Surgical Institute [Karolinska Institutet] in Stockholm; the prize for Literature by the Academy in Stockholm [Svenska Akademien] and that for Peace by a Committee of five persons to be elected by the Norwegian Storting. I declare it to be my express desire that, in the awarding of prizes, no consideration whatever be paid to the nationality of the candidates, that is to say, that the most deserving be awarded the prize, whether of Scandinavian origin or not.

This is my only valid Will and cancels any previous testamentary dispositions that may come to light after my death.

Paris, the 27th November, 1895. ALFRED BERNHARD NOBEL.

Although from a legal point of view the will he wrote himself to dispose of one of the largest fortunes of his time was obviously defective and might very well have been refused probate on purely technical grounds, its meaning was clear enough. Its worst fault was its failure to state who should administer the residuary fund on a permanent basis. The executors were only to settle the estate and then convert the remainder into cash, which was then to be invested in "safe" securities. Who should take charge next?

This defect was cured by an act of the Swedish government providing for a permanent board of trustees representing the government as well as the institutions designated to select the prize winners. Thus, the annual procedure in regard to the management as well as the distribution of the prizes is regulated.

Nominations with proper motivation can be made by former winners and also by recognized institutions of learning or official academies in any country. Such nominations must be made before January 31 of the year in which the prize in question is to be awarded. The faculty of the Carolinian Institute, which decides on the prize in medicine and physiology, usually makes the announcement before October 31; the Academy of Science, in regard to the prizes in physics and chemistry, before the middle of November. The Swedish Academy, which selects the winners of the Literary Prize, usually is ready with its decision about the same date; but the Norwegian Parliamentary Committee often withholds the name of its candidate until the eve of the distribution in Oslo on the anniversary of Nobel's death.

SIR ROBERT ROBINSON

PROFESSOR AT OXFORD UNIVERSITY, HE WAS THE WINNER OF THE 1947 NOBEL PRIZE IN CHEMISTRY.

On that date, December 10, the new prize winners are invited to be in Stockholm. Usually they also bring their wives or husbands. At five o'clock in the afternoon there is a full-dress ceremony in the Stockholm Concert House, at which the King and members of the royal family are present, as well as court officials, members of the diplomatic corps, representatives of the Nobel Foundation and of the prize-awarding academies, government ministers and high officials, and prominent private citizens. It is apt to be a solemn occasion, with classical music and bugle signals at the various stages of the ceremony. The chairman of the appropriate Nobel Committee introduces each winner by a speech in which the reasons for the selection are stated in considerable detail. The winner is greeted by the King and then presented, amidst applause from the audience, with an especially designed diploma, a gold medal, and a certificate to the effect that the appropriate sum of money is at his disposal in a specified bank. The amount is always indi-

cated in Swedish currency, its value in other media depending on the current rate of exchange.

After this rather stiff, traditional ceremony is over, the whole audience, and sometimes additional guests, repair to the Stockholm City Hall, in the Golden Room of which the Nobel Foundation gives a formal banquet with members of the royal family (though not the King) present. Toasts are offered to the King and to the sovereigns of the various states from which the winners hail. Customarily, a representative of the Nobel Foundation speaks. For years Mr. Ragnar Sohlman has managed to recall, each year, a new anecdote or a fresh quotation from Nobel's writings. The winners are also expected to make a few remarks in their own languages, of which translations appear in the next morning's newspapers. After the banquet the guests assemble informally around small tables in the Blue Room or central reception hall of the building. There the Stockholm university students' chorus sings, and their leader may make an address to the new prize winners in the native language of at least one of them. Afterwards there is a good deal of visiting back and forth among the tables, and as the evening progresses the atmosphere becomes more and more sociable. The next evening the King gives a state dinner in the royal palace, at which there are no speeches. Before leaving Stockholm, each prize winner is expected to make an address or deliver a lecture on a subject connected with his work before an assembly of his Swedish colleagues. All other functions to which the laureates are invited are informal.

TELESCOPE ON MOUNT PALOMAR

That earth was level, mankind once conceived;
Only his eyes could trace its true dimension,
Till Galileo, with a strange invention,
Destroyed the myth each man and child believed.
Then with new eyes to probe beyond his sight,
Man found a universe where he could grope
Among the stars: a minute telescope
That hurtled him through centuries of light.

Yet still so much he could not see, or guess:
Is space a curve? The universe expanding?
What is infinity? And nothingness?
Now, trembling near the brink of understanding,
Man, through the vast new lens at Palomar,
May bridge the ultimate void from star to star!

MAE WINKLER GOODMAN

WHAT IS SCIENCE TALENT?

ZACHARIAH SUBARSKY

Mr. Subarsky, after taking his M.S. at Columbia, taught biology in several New York City high schools. Formerly head of the Science Department at the Benjamin Franklin High School, he is now chairman of the Department of Biology and Introductory Science at the Bronx (New York) High School of Science, from which several winners in the Science Talent Search have come.

IN HIS report *Science and Public Policy*, Dr. John R. Steelman, Chairman of the President's Scientific Research Board, recommends that in the next decade total expenditures for research and development should be doubled, that expenditures for health and medical research be tripled, and those for basic research be quadrupled. The report points out that by 1957 we should be devoting at least 1 percent of our national income to research and development in universities, industry, and in the government. This would call for an annual expenditure of some two billion dollars, much of this being public funds.

The effective utilization of so vast a source of revenue presupposes the existence of an adequate number of mature scientific investigators. Unfortunately, the supply of trained scientific personnel needed even today is reported as woefully inadequate (*Steelman Committee Report, Vol. IV*). A vast and carefully thought-out plan for the detection and cultivation of science talent would, therefore, become strategic in any such national program. It was probably in anticipation of this bottleneck that the Bush Committee Report, *Science, The Endless Frontier,* called for the establishment of six thousand scholarships for "science-talented" high-school graduates, each scholarship to provide full tuition and living expenses at any recognized college or university.

Fortunately, a search for science talent is already under way among high-school students. Annually, forty high-school seniors, winners in the national Science Talent Search, are invited to Washington, D. C., to compete for science scholarships in the five-day Science Talent Institute, conducted by the Westinghouse Educational Foundation in cooperation with Science Service and its Science Clubs of America. The Science Talent Search represents an intriguing educational venture entered into by a private corporation. The project is admittedly experimental. Nevertheless, its influence has already proved to be nation-wide, and its implications are far-reaching. Educators have long been pondering over scientific method, scientific attitudes, and scientific thinking. The Bush Committee recommendations and the Science Talent Search bring into focus a new facet in science education, namely, the endowments and predilections that are essential in the development of a scientist. What are these endowments and predilections? In short, what *is* science talent?

A fundamental ingredient of science talent is a high degree of innate curiosity. This generally manifests itself early in the life of a child. What makes Sam incessantly and persistently tinker with electric currents? What moves Harry to absent himself from school during the height of the bird migratory season to go out and observe the waves of warblers? What drives Alice to the marshes to collect still more different kinds of protozoa, and what keeps her bent over the microscope for hours at a stretch? True, in many cases such "passions" gradually peter out. In some cases, however, curiosity ripens into enduring interest, which leads eventually to a lifetime of endless adventure in research.

Another manifestation of science talent is the ability to spot or detect an incongruity or inconsistency (commonly called a "problem") when confronted by facts. How many bacteriologists from Pasteur to Fleming have

had bacterial plates contaminated with molds! But it took a Fleming to spot the zone of inhibited bacterial growth and to pursue the investigations that led to the discovery of penicillin. Many horticulturists and animal husbandmen had hybridized living organisms before Gregor Mendel. But it took a Mendel to become so challenged by the very fortuitousness of the results of his predecessors, Kolreuter, Gartner, Herbert, Lecoq, Wichura, and others, that he was impelled to set up the experiments now regarded as classical. The mind of Joseph Black was arrested by the fact that the temperature of a mixture of ice and water does not rise even while a fire is under it, and that the temperature of boiling water in a kettle does not rise even as it sits over an open flame. Black was thus led to develop the concepts of latent heat and specific heat, concepts of great practical importance in engineering and meteorology. Similarly, Roemer was startled by discrepancies in the times of the eclipses of Jupiter's satellites, an observation that led him to the fundamental discovery of the speed of light.

When children are placed in a suitable environment, this element of science talent, namely, the ability to spot a problem, may soon manifest itself. A group of high-school students was assigned the job of maintaining several cultures of bacteria. Among these bacteria was the organism *Serratia marcescens.* Only one boy in the group seemed to be bothered by the observation that colonies of this organism are sometimes red, sometimes pink, and sometimes even colorless. Why did these different colors occur? He was interested to the extent of setting up an elaborate series of experiments to get the answer.

Photo by Jerome Metzner

STUDENTS IN THE FIELD

In the same laboratory dozens of students had observed that a large number of frogs kept in the frog tank were infected with the disease called "red-leg," but only one student was puzzled by the fact that the proportion of infected frogs in the laboratory was

greater than the proportion of infected frogs he observed in nature. He set up a number of experiments to determine the reason for the difference. As a result of his findings, the number of infections in the frog tanks was cut down from about 60 percent to only 2 percent!

Just as important as the keenness to spot incongruities and inconsistencies is the power to develop by intuition, as it were, tentative explanations that can be tested by experimentation or by wider observation. Kepler's laws of planetary motion, Newton's theory of the propagation of light, Avogadro's hypothesis that equal volumes of gases have the same number of molecules, Mendelyeev's prediction of the properties of elements that had not yet even been discovered, Maxwell's theory of the propagation of electromagnetic waves, the electrolytic theories of Van't Hoff and Arrhenius, Kekule's formula for the benzene ring, the theory of organic evolution advanced independently by Darwin and Wallace, Morgan's theory of the gene as the vehicle of biological heredity, the planetesimal hypothesis of Chamberlin and Moulton, Einstein's theory of relativity—such products of creative imagination are only a few of the milestones in the history of science. Indeed, it can be said that modern science is the product of human imagination checked and double-checked against experience. To few mortals is it given to make such breathtaking syntheses as those listed above. Nevertheless, a degree of creative imagination is called into play in the daily life of the scientist, who, confronted by a problem, must formulate hypotheses and plan experiments to test them.

Photo by Martin Weiss
ANNEALING A THERMOMETER
THIS INSTRUMENT WAS MADE BY THE STUDENT.

Photo by Martin Weiss
MARCIA'S MICROSCOPE
MICROSCOPY TAKES ALL HER SPARE TIME. WHY?

Thus, the boy who worked on red-leg infections in frogs suspected that the low incidence of red-leg among wild frogs might be due to the fact that wild frogs tend to burrow into the muddy bottom of pools, a condition that might be deleterious to the infective agent. He was guided by this hypothesis in setting up his experiments.

Another student's curiosity was aroused by an incidental observation in an experiment. Bernard became interested in the comparative

effects of carcinogens in differentiated tissue (tail of a tadpole) and undifferentiated tissue (limb bud of the same tadpole). In his control tadpoles he injected the normal solvent (sesame oil) of the carcinogen employed. He observed necrosis in all cases at the site of the injection of both the control and experimental animals. This fact he did not permit to pass as a mere *observation*. He made it the subject of a further experiment in which sesame oil *alone* was injected into the experimental tadpoles and physiological saline was injected into the controls. He found to his surprise that, for tadpoles at least, sesame oil, an oil commonly used as a solvent for biologically active substances such as hormones, was far from biologically inert itself.

A third ingredient of science talent is the ability and predilection to think in quantitative terms. Such talent was shown by Faraday when he discovered that the quantities of different substances deposited by an electric current of given intensity were proportional to their atomic weight divided by their chemical valence; and by Joule who found that a definite amount of heat appears when a given amount of mechanical energy is converted into heat and that, conversely, a definite amount of mechanical energy appears when a given amount of heat is converted into mechanical energy. In fact, the evolution of a given science is measured by the extent to which qualitative observations are translated into quantitative terms by instrumentation, by the application of mathematics, or by other ingenious devices.

Recently, scientists have devised international units of vitamins, hormones, antibiotics, and pesticides. Experimental work with these substances becomes ever more quantitative. For example, in describing some recent researches on new fungicides, Dr. K. Starr Chester writes (SM, 1948, **66**, 157):

> When the dosage of the chemical [fungicide] is varied, there is corresponding variation in response of the fungus spores. If dosage is plotted against toxic effect on a probability-logarithmic grid, there results the "dosage-response curve," a beautiful tool revealing much about the dynamics of fungicidal action.

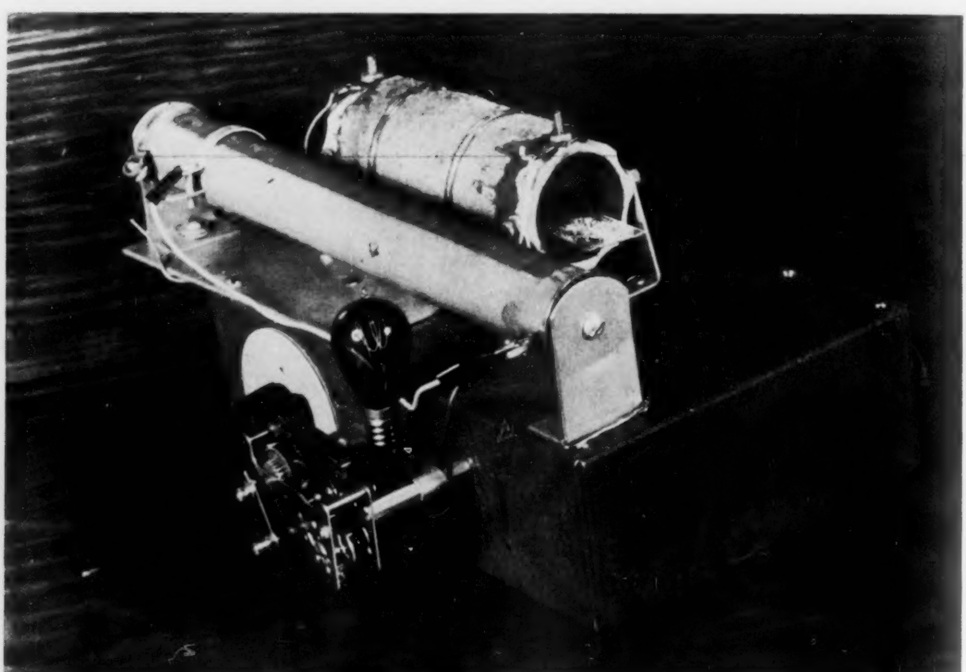


Photo by Martin Weiss

A MICROINCINERATOR CONSTRUCTED BY A HIGH-SCHOOL STUDENT

Photo by Martin Weiss

AN INCUBATOR DESIGNED AND MADE BY TWO HIGH-SCHOOL STUDENTS

Herbert, a high-school student, became interested in the fact that when bacteria are transplanted into a test tube there is a lag in their rate of reproduction despite the apparent optimum of conditions in the tube. Here, in his own words, is the way he went about trying to find out the reason for this lag:

> A culture of *Escherichia coli* in the logarithmic phase is treated in such a way as to stop its growth, by altering such conditions as food, temperature, pH, oxygen, carbon dioxide, etc. After treatment, the organisms are subcultured in fresh media, and the growth plotted for from three to four hours. Controls must be used in all cases.

This boy is manifesting a high degree of talent not only in the matter of formulating hypotheses but also in thinking quantitatively.

Robert, another high-school student, intensely interested in bird life, became curious about bird tracks. He proceeded to make plaster casts of tracks of birds' feet, but he was not satisfied with merely making and collecting the casts. He took measurements (Table 1).

TABLE 1

SUMMARY OF 45 CASTS

	Mid-toe			
	Length in mm.	Width in mm.	Number of Casts	Frequency of Palmation
Piping plover	18–20	1–5.2	2	....
Semipalmated sandpiper ..	19–21	1–1.5	5	2
Sanderling ...	20–24	2–3.5	6	....
Semipalmated plover	23–27	2–3.0	7	....
Spotted sandpiper ..	24–27	1–2.5	5	....
Killdeer	28	3.5	2	....
Ruddy turnstone ..	26–31	2–4.0	7	....
Dowitcher ...	31–40	2–5.3	5	....
Black-bellied plover	36–49	4–6.0	3	1
Red-backed sandpiper ..	25–27	2–3.0	3	....

Here, in his own words, is how this boy used this information:

I had practically haunted the marshes around Eastchester and Pelham Bays and had never seen or heard a Clapper Rail. After discovering their tracks and noting the spots they frequented, I was able to find several of these secretive birds. This illustrated one use of the method. It may also be used to distinguish between the Eastern and Long-billed Dowitchers, and the Eastern and Western Willets. This is a difficult task with binoculars, and one for experienced observers only.

Here is a case of a high degree of specialized curiosity coupled with quantitative thinking.

A fourth ingredient of science talent is manual dexterity, manipulative ability, mechanical-mindedness, or whatever other name such ability may be called. Between 1924 and 1927 Van Slyke described an apparatus he had devised "for the combined determination of all gases in a sample of blood; methods for micro-analysis of fractions of a c.c. of blood; for determination of gases in liquids saturated at high tensions; for determination of dissolved gases in water; and for air and general gas analysis." This gasometric apparatus was nothing more than an ingeniously assembled collection of vessels, tubes, and stopcocks; yet this apparatus, with the many modifications that have since been made in it, constitutes a most important contribution to physiology and engineering. In this category belong also the many types of colorimeters (which compare color intensities of solutions), nephelometers (which compare opacity of suspensions), pH meters (which measure the concentration of hydrogen ions), the Geiger-Müller counter (which measures nuclear radiations), the many types of centrifuges (which separate suspended substances of different masses). One might go back to such "ancient" instruments as the thermometer, microscope, and telescope to get an appreciation of what these "mechanical" devices have meant in the development of science.

Even high-school students, under certain conditions, display mechanical-mindedness and manipulative ability. A group of students were growing microscopic animals. There were requests for some of these animals from distant places, to which they could be mailed. It occurred to one boy that these animals might be sealed in a glass ampule and thus be shipped without danger of spilling or drying. He worked it out successfully. Another student who had demonstrated a beautifully made Tesla coil, when asked where he got a certain part of it replied, "I cut it off my mother's andirons."

Stuart and Morton were about to embark upon a project involving surface growth of a mold. The school incubator was too small to accommodate the liter flasks. The boys would not let this difficulty stand in their way. They set about constructing a large enough incubator. Without very much previous experience for the task, they successfully solved the problems of insulation, thermostatic control, and interior design, and they came forth from a cellar workshop with a very creditable piece of laboratory equipment.

Bert, a member of the Cancer Club, came across a paper describing some work involving the microincineration of tissue. He examined the figures carefully, made his own modifications, procured the parts, and constructed the apparatus he is now using in his own microincineration work.

The cases of these high-school students have been cited to exemplify the elements of science talent: specialized and persistent curiosity, alertness in detecting inconsistencies, creative imagination in projecting possible explanations for such inconsistencies, and a high degree of mechanical-mindedness. How can such talent be detected and cultivated? The importance of this problem will become accentuated when and if Congress passes the bill establishing a national Science Foundation. Fortunately, we shall be able to lean on the experience of the national Science Talent Search for the Westinghouse scholarships, now in its eighth consecutive year. However, this is a search for talent that is flourishing. To enable it to flourish, we must set up school conditions that will bring out the best science talent in American youth.

AMERICA GROWS CORN

HOWARD ZAHNISER

When spring comes to America
The farmers of forty-eight United States
Get up from their breakfasts
And plant a hundred million acres of Indian corn.

Out of the south into Texas
The corn-planting time moves into February,
Drifts northward thirteen miles a day,
Sweeps northward across a nation,
Comes to March, to April, to May,
Comes to forty-eight sovereign and united states.

And in every State of the Union
The farmers get up and plant their Indian corn.

(Only man grows corn.)

In Iowa where the tall corn grows,
In Ohio and Illinois,
In Indiana, Kansas, and Nebraska,
In Minnesota and Dakota,
In Georgia, where more acres grow corn than grow cotton,
In Maine and California,
In Michigan, Kentucky, Tennessee, Alabama, and Louisiana—
In every State of the Union—
The farmers of America plant corn.

(Only men and their women grow corn.)

Seed corn on a hundred million acres,
Planted with care and with pride
To rise into the rank and file
Of the greatest crop that man has yet mobilized.

Roasting ears, corn-on-the-cob, succotash,
Canned corn, dried corn,
Corn-meal mush,
Johnnycake,
Corn flakes,
Corn syrup.

Seed corn rising to feed
The cows, the pigs, the poultry,
The livestock of forty-eight States.

Seed corn rising to feed
Men and women and boys and girls.

Seed corn rising to feed them
With as good food as the good earth grows.

(Only men and their women plant corn in the earth.)

Say "corn" to the English and they think about wheat.
Say "corn" to a Scotchman,
And he kens you're talking of oats.
Say "corn" to any man,
And he thinks of the greatest grain of his native land.

Say "corn" to the American, and he knows you mean CORN.

Be English and call it maize.
Be scientific with *Zea mays.*
Call it whatever you will,
It grows on a hundred million American acres,
Grows and yields right well—
Yields corn enough
To give two dozen bushels to every man, woman, and child
In the United States of America.

Clear the living rooms of America!
Make way for Indian corn!

For every man, woman, and child in the United States of America,
Two dozen bushels of Indian corn.

Picture the baby
On the living room floor
And twice a dozen baskets full of corn.

Picture the preacher
In the pulpit
And twenty-four bushels of Indian corn.

Picture every man, woman, and child
In the United States of America
With twice a dozen bushels of corn.

Make it into succotash, corn meal, corn flakes, and syrup.

Feed it to the cows, the hogs, the chickens.

Feed ninety percent of America's corn
(And we do. We usually do.)
Feed ninety percent of America's corn
To the cows, the hogs, the turkeys, the chickens—
And taste the beef,
The pork,
The milk, the cream, the cheese, the eggs,
And smell the bacon in a thousand kitchens.

Courtesy of Associated American Artists Galleries, New York, N. Y.

"THE CORNFIELD," BY JOHN STEUART CURRY, 1935

And who grows the corn?

Only men and their women grow corn from the earth.

Columbus discovered America in 1492.
Columbus discovered CORN.
Cortez marched on the Aztecs,
And he ate corn.
Pizarro pillaged Peru,
In 1532,
And the Incas were harvesting corn.

But no man knew
Where the wild corn grew,
And no man knows
Where wild corn grows.

(Only man grows corn from the earth.)

The scientists of America study corn—
Yet they don't know
Where the wild plants grow—
The scientists of America study corn,
And dreaming and scheming,
And plotting and planning,
With tall talk
Of chromosomes, genes, and megaspores,
The plant breeders of America
Do a new thing under the sun
With their old friend *Zea mays.*

And Indian corn is hybrid corn!

Sing the praises of hybrid maize.
Sing the praises of man.
Men with their scheming have managed to raise
More bountiful corn than Nature can.

Take if you will an inbred strain.
Make your selections again and again.

Do it some more
And choose out four.
Call one A, and call one B.
Call one C, and call one D.

Call them in rhyme.
(It's corn-planting time.)
It's corn-planting time
For A with his B
And C with his D.

Watch the summer winds sway
The tassels on A,
The pollen-rich tassels of A,
And at harvest time see
The kernels on B—
The full-ripened seed of detasseled B,
Predestined to mate with the seed of CD.

For C with his D
Has a way
You can say
Is like A's with his B.

(But the grain they both yield
In the seed-grower's field
Makes no johnnycake, corn meal, or succotash,
Makes no chicken corn, cow feed, or hog mash.
Its fate
Is to mate;
Its deed is to breed.)

So call them in rhyme again
It's corn-planting time again.
And AB
With CD
Will cross and sublime again.
And the double-crossed grain that their harvest will yield
Is a new kind of seed for the corn farmer's field.

Thus Science discloses
Controlled heterosis,
And hybrid vigor
Makes corn yields bigger.

And Indian corn is HYBRID *corn.*

And the farmers of America
In the Year of Our Lord Nineteen Hundred and Thirty-three
Rise up from their breakfasts
And plant a hundred thousand acres of hybrid corn.

And when harvesttime comes
They like it.
And ten years later
They rise up from their breakfasts
And plant fifty MILLION acres.

Sing the praises of hybrid corn
    To the tune of twenty percent.
Hybrid vigor in *Zea mays*
    Boosts the yield by twenty percent.

Yes, SIR!
The corn growers of America
Get Six Hundred and Fifty Million bushels more
For their time and their trouble
Than they could have
Without the magic of hybrid corn.

Sing the praises of hybrid corn
To the tune of twenty percent.
Hybrid vigor in Indian corn
Boosts the yield by twenty percent.

Feed it to the hogs of America.
Feed Six Hundred and Fifty Million bushels of Indian corn
(And we feed them more than that. We certainly do.)
Feed Six Hundred and Fifty Million bushels of Indian corn
To the greedy, grunting, squealing, pork-growing pigs of America,
And how much pork do you get?

BROTHER, you get pork enough
To give three pounds
To every man, woman, and child on the face of the Earth.

Sing the praises of hybrid corn
To the tune of pork at your meals,
For seven BILLION pounds of pork
Is hybrid vigor in *Zea mays.*

But no man knows
Where the wild corn grows.

(Growing corn is a human thing.)

When spring comes to America
The farmers of forty-eight United States
Get up from their breakfasts—
They and their sons and their daughters too—
In every State of the Union
The farmers of America
Rise up from their breakfasts
And plant a hundred million acres of Indian corn.

And before
And behind them
Across the cornfields of America
A
nation
moves
with
them.

AMERICA GROWS CORN!

GROUP MEDICAL PRACTICE

BENJAMIN F. MILLER

Dr. Miller (M.D., Harvard, 1933) interned for a year at New York Hospital and then spent two years as a National Research Fellow. In 1937 he went to the University of Chicago as assistant professor of medicine. Last year he took on a double assignment in Washington, D. C., with the National Research Council and the George Washington Medical School. The following article is from Chapter 5 of Dr. Miller's book You and Your Doctor, *which won honorable mention in a contest sponsored by Whittlesey House and* Science Illustrated.*

THE practice of medicine by groups of physicians has already proved its value in a number of places throughout the country. Groups of various sizes have been set up and are flourishing. They range from combinations of a minimum of five to ten physicians to the large group clinics, such as the Ross-Loos in Los Angeles, which cares for approximately 60,000 individuals, the successful Permanente Foundation set up by Henry Kaiser on the west coast, the Mayo Clinic, the University of Chicago Clinics, the group clinics set up by large trade unions, and many others.

In these groups, doctors band together in a logical combination to improve their standards of practice. Physicians possessing different skills work together, sharing not only their experience and specialized training, but also all their equipment. As a result, the patient has ready access to all types of medical treatment and to the most modern facilities. In many instances the groups are organized on a prepayment basis, which guarantees continuous medical care to the subscribers.

Group medical practice has certainly not been welcomed by all medical societies, and was actually fought bitterly. Its successful survival is the proof that the public needs and welcomes this kind of medical service. In recent years the opposition has virtually given up the fight. It continues to carry on a strategic retreat—a losing battle—for it is forced to recognize that the progress of group medicine cannot be checked.

Doctors and medical students alike look with favor on some fundamental change in the structure of medical practice. In a recent survey conducted by the American Medical Association, 63 percent of all doctors polled indicated a preference for some form of practice other than the traditional form of solo practice on a fee-for-service basis. Fifty-three percent wanted to enter some form of group practice.

Many of the physicians who served in the armed forces during the war are forming group clinics for civilian practice. These men worked in close cooperation with their colleagues in service hospitals and units; they had daily opportunities to appraise the expediency of these methods, and have retained the desire to incorporate the best features into their own practice. It seems unlikely that the impetus that the war gave to cooperative medicine will come to nothing. The concept of group practice has been growing for a long time, and not even the most fervent propaganda against it has succeeded in blocking it. Opposition has undoubtedly slowed its development, but it is comforting to realize that throughout history no entrenched group has ever permanently halted any movement that is on the side of true progress. Group medical practice has already proved itself to be a step in the right direction for the patient, for the doctor, and for nurses and technicians. It is a good, square deal for everyone concerned.

Let us assume that you are a patient going through a typical group clinic. When you arrive, you need not waste time or anxiety over your financial arrangements if they are on prepayment basis. If it is your first appearance at the clinic, you will receive a

* *You and Your Doctor* is scheduled for publication April 23. This extract is printed by special permission of the McGraw-Hill Book Company.

very thorough examination. First, there will be a laboratory checkup. Your blood will be tested to determine whether your red and white corpuscles add up to the correct total, so that anemia and other illnesses can be ruled out. The urine is examined for albumin, sugar, etc., to eliminate the possibility of nephritis, diabetes, and other maladies. A Wassermann test for syphilis is done routinely on all patients. If you protest this as a personal affront, you will be assured that anyone in the world, regardless of his style of life, philosophy, annual income, or tastes in entertainment, can contract syphilis. There are even cases on record with no venereal contact at all. The failure of the general practitioner to perform Wassermann tests routinely on every patient is a strong indictment against him, and has proved to be the source of completely avoidable but nonetheless tragic illness. In group medical practice, the Wassermann test becomes so routine a part of the general examination that you won't give it a second thought.

You are next sent into the X-ray or fluoroscopy room, where your chest is X-rayed or fluoroscoped. This takes only a few minutes, and with the new techniques you don't even have to undress. This examination can reveal the presence of tuberculosis in the lungs and also provides valuable information about the heart and other structures inside the chest. Judging from the number of cases discovered in recent surveys, there are over half a million people in the United States with unsuspected active tuberculosis of the lung. Undoubtedly, many of these individuals have consulted their physicians countless times, but the tuberculous infection was not detected because, in the early stages, it can be found only by X-ray or fluoroscopy techniques. In a group clinic where such techniques are part of the routine examination, many cases of incipient tuberculosis have been discovered at a time when they can be treated and cured. This is preventive medicine that actually saves lives.

You are now ready for the examining room. Here a young physician will take a complete medical history, which includes details of the present and all past illnesses, and he will examine you carefully. An older, senior physician is then called in. In a group clinic connected with a medical school, a fourth-year student makes the initial examination, and the older physician is generally an instructor or professor in the medical school. In either case, the more experienced physician will sit down with the student, intern, or young physician, and listen to an account of the illness and the assistant's findings. He will ask him to analyze the case and suggest a diagnosis, and together they will decide what further tests are required to verify the diagnosis. This constitutes important training for the younger doctor, since all his decisions are checked by an older and more experienced man.

The young physician or student who examined you now returns with the senior doctor, who checks the findings, and perhaps clarifies some aspects of the illness that the younger doctor may not have grasped. This concludes the teaching process. The senior physician then explains the findings to you, recommends any additional tests or X-rays that may be necessary, and tells you what treatment should be started. Before you leave, arrangements are made for a return visit, usually within a week or two.

In this manner, a thorough and careful examination is carried out with considerable saving of time to the senior physician. Because he has confidence in most of the routine preliminary checkup by the younger doctor, he can focus his attention on the abnormal findings. If your examination reveals high blood pressure, the doctor will be particularly painstaking when he checks the heart, the kidneys, and other organs that are apt to be affected by high blood pressure. If you have bronchial asthma, he can concentrate on a very thorough examination of your lungs and heart. He has not had to spend time on details that a less experienced doctor or student can be responsible for. Simultaneously, the younger physician has been given an opportunity to practice medicine and improve his knowledge. And you as the patient have had the benefit of a double check by two doctors.

Before your return session, the senior phy-

sician studies your laboratory reports and the notes on any X-ray examination. By the end of your second visit, he will have gained a reasonably accurate picture of the illness and the treatment required. If you need specialized treatment that he is not qualified to provide, he will refer you to the correct specialist in the clinic. But he will continue to check on your progress, and to receive your reports. He is your doctor, and he is the man you will always see for any new illness.

A SMOOTHLY functioning group offers obvious advantages for everyone connected with it. New patients in a group have frequently been heard to comment that this was the first "real examination" they ever had, the first time the doctor had sat down and taken the time to find out everything that might be wrong. The patient is not always aware that this method is also beneficial to the doctor, who, thanks to the students and assistants who completed the preliminary examination, has been left free to be painstaking in dealing with each new patient. Furthermore, the student or younger physician has been given the inestimable advantage of making independent examinations and diagnoses under the supervision of older, more expert physicians. This is a very important contribution of good group practice. The young physician who goes into practice after a one-year internship remains isolated, and seldom has anyone to consult when he is uncertain about a case. He accepts a tremendous responsibility for which he is not yet prepared. In the group, the younger doctor is under the supervision of a doctor with infinitely greater experience. The younger physician is trained and given responsibility at a graduated rate until he can be independent, and is never kept in the prolonged state of dependence that is so frequently the fate of the assistant to the private practitioner. Meanwhile, the senior physician, knowing that his routine work is in good hands, can allocate more hours to his hospital patients, to teaching, and to research.

In a group, specialists are accustomed to working closely with one another and with the diagnosticians, and find no obstacles to obtaining information in other fields. Such interchange of knowledge is surprisingly difficult to arrange in private practice and constitutes an unfortunate limitation for both the doctor and the patient. I saw a patient some time ago who illustrated this very dramatically. She came to our clinic with a perfectly obvious case of high blood pressure. The diagnosis was readily established and treatment started. During the preliminary examination, the younger doctor noticed a small ulcer, about a half inch in diameter, on the palm of her hand. When she was asked about it, she answered casually that she had had it for at least a year and that all the doctors who had seen it had assured her that it was a mild type of ulcer. It had never been treated, although it had opened and closed repeatedly, and she had become quite accustomed to the ugly moist area on her hand. Since we were not convinced that it was a harmless sore, we urged the patient to have it examined by a dermatologist. She was very reluctant and insisted that she had grown used to it, that it didn't bother her, and that she did not want to spend any money on it. I interpreted her last reason as the primary one, and assured her that it wouldn't cost anything to have Dr. X, our skin specialist, look at the sore. I walked down the corridor with her, and asked Dr. X to examine her hand. His experienced eye immediately observed the signs of a possible mild form of skin cancer. When cancer was mentioned, the patient's hesitation vanished. Dr. X removed a bit of skin and examined it under the microscope, confirming the diagnosis of cancer of a mild degree of malignancy. X-ray therapy was instituted, and the ugly sore disappeared rapidly. The patient was delighted to have a normal hand, and all of us learned a lesson from the case. Everything was easily arranged and proved inexpensive for the patient because of the organization of this group medical center.

A physician in private practice would also, undoubtedly, have noticed the lesion. But getting something done about it would have been considerably more difficult for him. The patient could much more readily have

persuaded him not to do anything about it because "she had become accustomed to it, and it didn't bother her." He would hesitate to antagonize her by insisting that she consult a skin specialist. In addition to the high fee, there would be the problem of the time and distance involved in getting to the specialist. And, even if the specialist were located in the same building, the practitioner would be conscious of a certain hesitation, derived from our system of private practice and private fees, of not wanting to sell the patient more than she came to buy. This patient might well have continued to take her lesion home with her and to have tolerated it until it really began to bother her. By then it might have been too late. A doctors' building, no matter how large or how modern, is still nothing more than the headquarters for an assortment of doctors. It cannot generate the type of informality and cooperation which exists in group practice, among physicians who work together day after day.

It is sometimes said that a group may operate more efficiently than the general practitioner, but cannot provide a good, intimate patient-doctor relationship. I can refute this argument from personal experience, and the experience of many colleagues in group practice. A smoothly functioning group offers a better rapport between the doctor and the patient. A double emotional relationship is established toward the patient's doctor and also with the group as a whole. I consider this double attachment very important. The patient comes to rely on his own physician and on the skills of the associated specialists. Confidence is inspired by the careful and thorough examination. He knows that if he is ill, the illness will be correctly diagnosed and treated, and that if he is told he is in good condition, there is every likelihood that this is true. The patient does not have a vaguely dissatisfied feeling because the doctor was too busy to hear all his symptoms, or because the examination was not thorough. He knows he has access to any specialist he needs without great expense. He can go to the group for treatment of relatively mild illness. Financial considerations will not force him to wait until obviously serious symptoms are manifested. Even through the dry dullness of a statistical chart, we can read the tragedy of the many who die or are permanently disabled every year because they did not receive medical care soon enough. Nor can we minimize the fact that the reason most of them did not obtain medical care was that they could not pay for it, or had to travel too far to get it.

A family attending a group clinic over a period of years becomes attached to the group as a whole. Their babies have been delivered by its obstetricians; they have consulted its surgeons and X-ray technicians; they have brought their children to its pediatricians; they have attended a variety of clinics over a period of years.

In a group, the physicians rarely discuss money with the patients. Instead, the fees are determined by experts in medical economics. To me, this is one of the finest elements in group medicine, and represents a genuine improvement in the physician-patient relationship. I agree with Dr. Sigerist that it is high time "the shopkeeper element" was removed from medical practice.

Another important consideration in establishing group clinics is their effective utilization of modern medical equipment. Rarely can the general practitioner afford the variety of expensive apparatus required for accurate diagnosis and treatment. Today, one doctor may own an expensive fluoroscope; another has his own electrocardiograph machine; another supports his own laboratory. These doctors do not share their patients with one another, and they are no more likely to share their equipment. The patient whose family doctor boasts a fine modern electrocardiograph machine is lucky if he needs an electrocardiogram, but if his condition calls for fluoroscopy, he is not very fortunate. In the group clinic the essential equipment is on the premises, and its cost is shared by the unit as a whole. An active group can support good X-ray equipment, a complete laboratory, and even good physiotherapy equipment.

The ideal group works in close proximity to the hospital to which it refers its patients, and they can be attended there by the physi-

cians who made the diagnoses. As anyone who has ever been hospitalized knows, this is a great comfort to the patient and spares him a good deal of emotional disturbance. It is also a good arrangement for the doctor because of the obvious educational advantage in following an illness from its initial diagnosis, through its entire course, to the final convalescence.

The opportunities for the doctor to continue his education under group practice are not to be overlooked. Almost every doctor plans to attend conventions and conferences and to take an occasional refresher course, in order to keep abreast of medical developments. But by the time a man has built a large and devoted general practice, he finds himself anchored to it. He cannot go away for a month or, often, even for a week. His patients will resent it. Often there is no one who can take care of his practice while he is away. Young doctors, who especially need additional training, find it even more difficult to leave the practice they are establishing. An operation is scheduled, if possible, at a season of the year when conditions will be most favorable. A maternity case cannot be suspended to enable a doctor to go to a scientific meeting. The average physician in a small town finds himself completely cut off from medical progress, except for what information he can obtain from reading in his very limited amount of free time. Yet, refresher courses for the doctor are not a means for self-indulgence, but are vitally necessary to the care of his patients.

In group practice such efforts are perfectly feasible and are encouraged. The doctor is not inextricably tied down to his routine. His patients have faith in the group as well as in him. They know that the doctors work together, that they discuss diagnosis and treatment with one another, that the group attempts to maintain a uniformly good staff. If the doctor leaves the clinic for a brief period for a scientific meeting or a refresher course, they know that he will return an abler physician, and that the dividends of his period of study will accrue to them. The records of a group are complete and carefully kept, so that if Dr. A arranges with Dr. B to take care of his patients for a while, the transition can be made easily and the patient will experience no anxiety. The patient may already know Dr. B from occasional contacts in the clinic. When a private practitioner leaves his practice for any reason, he creates a void. In a small community, the patients frequently have no other doctor to go to. When a member of a group takes time off, the group continues to function, and the patients continue to receive good care.

Sufficient leisure to follow the progress of medicine is by now taken for granted in all groups attached to large hospital centers and medical schools. But this principle can and should apply to every group. Even the smallest group unit in the most isolated community can arrange for occasional leaves of absence for members of its staff without materially lowering the quality of its service. In the sparsely settled and remote counties of the nation, the small units consisting of six to ten doctors could easily serve the average medical needs of one or more counties by means of improved transportation arrangements. The educational activity of the group could be predicated on some plan of rotation. The experienced physicians would always have younger doctors in training who would assume responsibility whenever their absence was necessary. This would be equally possible for other members of the staff whose specialties coincided at certain points. For example, although there would probably be only one general surgeon in a small group, he could, for brief periods, leave his patients in the care of the group's obstetrician and gynecologist who also has had a good training in general surgery. This interlocking of skills in even the smallest group clinics frees the doctor and permits him to keep abreast of advances in his profession. It represents an incalculable improvement over the lot of the general practitioner who is continuously harnessed to his practice. Well-organized and well-located groups in rural areas are not merely desirable; they are indispensable unless we are ready to admit that we are totally indifferent to the health of our huge rural population.

We are a sufficiently rich and ingenious nation to work out a satisfactory method for the payment of doctors, groups, and hospitals, once the advantages of this type of practice are generally recognized. Groups already in existence employ various methods of payment. Some, like the Ross-Loos Clinic in Los Angeles, the Chicago Civic Medical Center, the Group Health Association of Washington, D.C., and the Farmers' Union Cooperative Association, of Elk City, Oklahoma, operate on a prepayment basis. The Mayo Clinic, the Cleveland Clinic, the University of Chicago Clinics, and others charge for each clinic visit, but their fees are adjusted to the ability of the patient to pay.

The average citizen is not aware that several of the group clinics now in operation are providing some of the best medical service in the United States; their medical staffs include a number of the most distinguished physicians in the profession; their patients prefer this type of medical care to any other. Fortunately, despite opposition from the American Medical Association, these groups have grown and have developed into some of the best medical centers in the world. Not only have they raised the standards of medical service generally, but they have also, in some instances, conducted important research projects. They show the efficacy of group practice.

Certain groups are so successful and so completely accepted that they are now unassailable; hence the attack is directed against smaller groups and the concept of prepayment. The dread adjective "socialized" has been transferred from institutions like the Mayo or Lahey clinics to the smaller medical groups and the prepayment plan. We are now supposed to be impressed by the sanctity and holiness of the private fee. It is "socialization" to put the doctor on a salary. Yet the doctors at the Mayo Clinic, the University of Chicago Clinics, and the Cleveland Clinic have worked on a salaried basis for years. I am sure that a referendum among doctors and medical students would indicate that they prefer a fair salary to the first ten or fifteen years of economic struggle in private practice, so that they could practice medicine instead of bookkeeping. The sanctity of the individual physician's fee may be an obsession with some of the more reactionary representatives of the medical profession, but it definitely does not represent the most pressing problem for either the medical profession or for the nation. The problem is to provide the nation with adequate medical service, and the medical profession with an efficient and logical method of practice.

SEND THE SM TO VETERANS' HOSPITALS

Having reason to believe that patients in Veterans' hospitals want to read scientific as well as popular magazines, the Engineers' Society of Milwaukee has appealed for contributions of technical journals to the local hospital. As the response was gratifying, Samuel R. Snead, of that Society, suggests that the appeal be made on a national basis. Specifically, we suggest that unneeded copies of the SM be sent to the nearest Veterans' hospital. The SM has the desired meat in it, without being terrifyingly technical.—Ed.

THE FAITH OF SCIENCE

ARTHUR WARD LINDSEY

Head of the Department of Biological Sciences at Denison University, Dr. Lindsey (Ph.D., Iowa, 1919) has spent most of his academic life at Granville. In the article below he succeeds so well in his attempt to state concisely the relation of faith to intelligence and the place of faith in scientific thought that the editors felt obliged to reconsider their decision to publish no more articles on this subject.

WE MAY hope that the day of violent controversies between the proponents of the religious point of view and those of the sciences has gone forever, but there is still a yawning gulf between them. The religious man is concerned with the mysteries of life and the hereafter for which he has no direct evidence of the senses. The scientist requires that evidence as a necessary foundation of belief. Religion, therefore, is free to accept on a basis of faith the concepts that are most comforting, whereas science demands the suppression of individual feeling in the relentless search for truth.

Scientists themselves, since they are human, have the same capacity for faith and feeling and belief that other men may have. They may reach sound conclusions without following the stony path of detailed research and may feel strong convictions that are not amenable to scientific investigation, but no scientist can be content to rest his thoughts on such foundations. Knowing the fallibility of human observation, he must test his hypotheses by reference to the natural world. He must safeguard his observations and experiments by the most exacting checks and must anticipate all alternative interpretations as fully as possible before he can be convinced that what he believes is not merely a product of his own mind, but also an interpretation of the actual phenomena of nature.

This procedure is rewarding to intellectual men, but it is also costly. It is far easier for human beings to yield to the emotional processes of their minds than to subject their behavior always to rational analysis, for emotional behavior is far more deeply rooted in the remote animal ancestry of man than the elaborate intelligence that he alone possesses. The use of his more recently acquired powers of thought is exhausting. If he belongs to the peculiar breed of scientists he cannot be contented with any less than the best that his mind can do, and that ideal is likely to color his life or, better, to rob it of color, even where his emotions should rule.

As a result, scientists are liable to criticism as a cold and heartless lot. No doubt they deserve the indictment in part of their lives. Possibly some of them are too completely scientific in all their living, and possibly all of them are too precise at times in the exactions of their thinking. If that is their loss, they have a reward to compensate it in the beauty of precision that satisfies their type of mind.

That there is beauty in precision of thought may not be an appealing idea to many men. Certainly it cannot appeal to those who do not have the capacity or are unwilling to drive their minds to the last degree of accuracy that may be the boundary between right and wrong. But once a man has known the satisfaction of following a problem through to the final correction of his own misconceptions and to final proof through the rigid methods of the laboratory, he can never again be satisfied with loose thinking. He has found the reward that President Wishart of the College of Wooster once characterized as the austere beauty of precise thinking.

It is a beautiful phrase, and apt. Austerity must be the mantle of scientific procedure and the cross of the scientist when his habit of mind carries over into contacts with other men. He can only echo Luther's cry: *Ich kann nicht anders.* His reward must come from the satisfaction that he knows so

well in his work, even though it may deprive him of some of the warmth of human life.

Science does not claim absolute understanding. Too much has been discovered within the twentieth century to permit any scientist to feel that what he knows today is all that can be known tomorrow, or that what seems accurate now may not be completely overthrown by the discoveries of another year. His own experience may very well have included the reversal of conclusions that he once held dear, and if he has lived a reasonable span of life the things that he was once taught have certainly been subject to revision. The atom forty years ago was the indivisible unit of matter.

The keen appreciation of the fallibility and incompleteness of human knowledge that must result from such understanding can have only one effect. We seek ultimate comprehension of ourselves and of the universe in which we live, and from the dawn of human intelligence have been formulating explanations according to the stage of our experience. Our one source of information has been our special senses. What we have done with that information in our own minds has varied widely, but it has always included concepts of the supernatural beyond reach of the senses, and these concepts have been potent in shaping and directing the course of human affairs. Scientists, like other men, have fallen back upon such methods of thought when they have reached the limits of scientific procedure, but with their scientific habit of mind they have often not required abstract concepts where other men might require them. They fully know that the incompleteness of knowledge has been lessened by degrees. If today they face an unknown, it can be faced in agnosticism with no craving for an explanation when accurate explanation is obviously beyond reach of our present knowledge.

WHILE their agnosticism touches no cherished creeds it cannot offend. They can disagree with the tenets of their friends in economics and philosophy and education at the risk of nothing more than scorn. Among themselves they may disagree heartily on these subjects and out of exasperation they sometimes express their feelings more openly, where they can be argued down by the opposition. But as a rule they keep such thoughts to themselves, knowing too well the futility of argument where facts are not available. The opposition is in the majority. It rises easily to defend its own position, secure in the knowledge that the poor scientist is handicapped by the clipped wings of his imagination. So the scientist cannot arouse deep feeling here.

But the matter of religion is very different. It is the crutch of the weak, the bulwark of the strong, and the self-declared salvation of our species. He who questions it is indicted, tried, and condemned for heresy in the minds of the faithful, for he strikes at the roots of their being. Yet scientists are human. They, like other men, face the awe-inspiring mystery of the universe and as thinking men must have some concept to adjust their own existence to the great unknown. What can they believe?

No part of science has brought this conflict so sharply into the open as organic evolution, which has flared into violent controversy even in the twentieth century. Since it seems to the literal-minded a direct contradiction of cherished biblical teaching, it has been bitterly opposed at times, so bitterly indeed as to bring into question the evolutionist's fitness to present his views to the young. Why should not such a field offer good testimony to the attitude of science on the ultimate power of the universe? We find this testimony in the beautiful passage from Erasmus Darwin's *Zoonomia,* antedating the work of his famous grandson, Charles, which caused the most serious discussions:

> The world has been evolved, not created; it has arisen little by little from a small beginning and has increased through the activity of the elemental forces embodied in itself, and so has rather grown than suddenly come into being at an almighty word. What a sublime idea of the infinite might of the great Architect! the Cause of all causes, the Father of all fathers, the *Ens entium!* For if we could compare the Infinite, it would surely require a greater Infinite to cause the causes of effects than to produce the effects themselves.

All that happens in the world depends on the forces that prevail in it, and results according to law; but where these forces and their substratum, matter, came from, we know not, and here we have room for **faith.**

When the knowledge of the astronomer reduces the heavens to ascensions and light-years and astrophysics, when the atom yields its secrets so fully that man can produce elements that do not exist in nature, when the geneticist traces the wonders of heredity to microscopic bands in the chromosomes, can the basis of faith be less? The simple world of our ancestors was wonderful enough to demand some explanation, but the world of modern science is infinitely more wonderful as a tribute to the Power that lies behind it. There is still room for faith, and if faith without knowledge is beautiful, then surely faith with knowledge is transcendent.

But in what shall the scientist have faith? Shall it be Michelangelo's God of the Sistine Chapel, or the great Byzantine Christ of Monreale? Shall it be a Lord willing to suspend the laws of nature to meet a despairing cry for personal advantage? Shall it be the promise of personal immortality, of heaven and hell? Shall it be the sinfulness of man and the need for expiation before a stern but forgiving Judge? Or shall it be faith in a nebulous Unknown, secure in the conviction that whatever that Unknown may be, he has given man the power to see for himself and to work out his own destiny through the courage and intelligence of his own being?

That intelligence has already transformed him from a solitary nomad, exposed to the elements and taking his food like any animal wherever he could find it, into a civilized being. It has given him control over his environment that would have seemed a thousand years ago like the power of a god. It has lengthened his span of life almost to the threescore years and ten of the Scriptures. Why should he question or try to estimate its capacity to extend his knowledge and control to unpredictable ends?

He must be concerned now as never before with the use of his knowledge for the destruction of his kind, but this danger only adds to his obligation to solve the problem of living in brotherhood. Here the tangible expression of the Christian religion gives him a system of ethics which, properly applied to human behavior, would solve all problems. Biology supports that system and brings science into close accord with religion in the affairs of men, not on an emotional basis but through purely intelligent understanding. Here the scientist is a supporter of the most practical aspects of Christianity. Can he go further?

For himself it is a personal problem. Men believe what they can believe, accept what they must accept of Christian principles for their own peace of mind. For others the scientist's attitude can be tolerant. He knows the variability of men. He knows that the deeply rooted emotions are present in all men, whatever their intelligence quotients, and that far more men can therefore be reached by emotional appeal than by pure reason. Since, in his own life, serenity can be attained only through that residuum of faith which lies beyond the limits of comprehension, he must not deny to others a similar right; and if their need is greater, even to the extremes of emotional worship, it is not his privilege to condemn. He can have faith in their religion for its value to them even if he cannot share their faith for its value to himself.

Few scientists are militant iconoclasts. That is a tribute to their intelligence. The few who are meet disapproval from their fellows scarcely less than from the proponents of religion. Since this is true, it seems that tolerant scientists should enjoy equivalent tolerance for their views from men of the Church, but this again is a matter of intelligence. Throughout the more emotional sects, both laity and clergy have been scornful of the scientific attitude to religion. They may condemn the agnostic even more bitterly than the infidel and may publicly denounce his beliefs. But the scientist also has abundant reason to appreciate the fine tolerance of many religious men for his own views and so to realize that the varied balance is only another expression of the variability of men.

Faith is for all men the recourse of the

mind when it reaches the limits of true comprehension. It is bound to vary as the capacity and habits of the mind vary, and so for the inquiring mind the domain of faith must be far more restricted than for the mind of a child. But its role is always the same. For every man it is the normal complement of reason.

If, for the scientist, the extension of his knowledge of natural forces into realms not even imagined a century ago brings a contraction of the realm of faith, there still remains a great Unknown that his intelligence cannot encompass. If his solution of mysteries once insoluble gives him confidence in the capacity of the human mind to solve the mysteries of the present, the realization can only add to the wonder of that Unknown. His faith must be greater, rather than less. His demands for a symbolic expression may be small or nonexistent, but faith must persist: faith in the majesty of the Unknown, faith in the manifestation of that Unknown in his own human powers, faith in the nobility of man's struggle toward perfection in spite of the discouragement of failures along the way.

Science must have faith. It cannot share the comfort of faith in a loving God who will ease the burdens of life on earth for the faithful and receive them into a gilded afterlife, for it knows too well the inexorable laws of nature. It cannot share a God created by man in the human image, for it knows too well the frailties of men. But it must have faith in the Infinite Power that lies behind the magnificent attainments of mankind and in the capacity of men to push on to greater heights.

The faith of science must be austere. It is a faith for the strong, a comprehending faith with sympathy for the beliefs of all men according to their need, a faith that demands of self before God, a faith of gratitude for what we are and of the obligation of man that has been put so well in the lines

> Work. Feed thyself. To thine own powers appeal
> Nor whine out woes thine own right hand can heal.

But it is still faith, the sustaining force that extends beyond intelligence to keep all men in harmony with the great Unknown. And in science it can still be beautiful with the austere beauty of precise thinking and noble with the dignity of self-reliance and gratitude.

GRAY EDGE

More than for building of a tower
Or lifting of a spire,
More than for stone on stone to house
The dust his hands desire,
Man wrestles with the arc of sky,
Horizon rim to rim,
Curving it for a smaller world
About the soul of him.
To circumscribe his going out
And shrink the nought of space,
Marking the center of the whole
Within his little place.
Yet all the while and without end
And none to make reply,
He paces on the gaunt, gray edge—
Alone against all sky.

ISABELLE BRYANS LONGFELLOW

THE UPPER LIMIT OF ABILITY AMONG AMERICAN NEGROES

MARTIN D. JENKINS

Professor Jenkins (Ph.D., Northwestern, 1935) has taught at Virginia State College, North Carolina Agricultural and Technological College, and Cheyney Training School for Teachers; since 1938 he has been teaching at Howard University. A specialist in educational psychology, Dr. Jenkins became interested in gifted children while studying for his doctorate.

MORE than three decades of psychometric investigation among American Negroes has yielded a rich fund of information concerning this population group. Perhaps the most generally known finding, and certainly the most emphasized, is that when "comparable" groups of whites and Negroes are tested, the Negro group is almost invariably inferior to the white in psychometric intelligence (intelligence as measured by psychological tests). Preoccupation with the significance of the low *average* performance of Negro groups has served to divert attention from an equally important phenomenon—the variability of the group, and especially the upper limit reached by its really superior members.

The question of the upper limit of ability among Negroes has both theoretical and practical significance. Psychologists generally attribute the low average performance of Negro groups on intelligence tests to cultural factors. It is well known that Negroes generally experience an inferior environment; and there is certainly no question but that an inferior environment tends to depress the psychometric intelligence. There are, however, many Negro children who are nurtured in an environment that is equal or superior to that of the average white child. Thus, we may hypothesize that *if race in itself is not a limiting factor in intelligence, then, among Negroes whose total environment compares favorably with that of the average American white, there should be found a "normal" proportion of very superior cases, and the upper limit of ability should coincide with that of the white population.* This hypothesis is especially attractive from a negative aspect; thus, if very superior individuals are not to be found in the Negro population, the environmental explanation would clearly be inadequate to account for the phenomenon. The existence of such individuals, on the other hand, would afford additional evidence, but not absolute proof, of course, of the validity of the environmental explanation of "racial differences" in psychometric intelligence.

The practical significance of the question is apparent. If Negroes are to be found at the highest levels of psychometric intelligence, then we may anticipate that members of this racial group have the ability to participate in the culture at the highest level. In these days of reconsideration of the role of the dark races throughout the world, this question has more than mere national significance.

Analysis of the literature relating to the intelligence-test performance of Negro children reveals that a considerable number of these children have been found within the range that reaches the best 1 percent of white children (I.Q. 130 and above) and at the level of "gifted" children (I.Q. 140 and above). There are at least sixteen published studies that give an account of Negro children possessing I.Q.s above 130; twelve of these report cases above I.Q. 140. These investigations were made by different psychologists in various localities and under varying conditions; moreover, the I.Q.s were derived by a number of different tests. Further, the populations studied were located almost exclusively in Northern urban communities. Consequently, one may not justifiably generalize, from a composite of these studies, concerning the incidence of Negro deviates.

It is of significance, however, that of the 22,301 subjects included in the thirteen studies for which N's are reported, 0.3 percent scored at I.Q. 140 and above, and fully 1 percent scored at I.Q. 130 and above. These percentages are similar to those obtained from a "normal" I.Q. distribution of American school children.

Of especial significance are the cases of very bright children of Binet I.Q. 160 and above. It may be estimated that fewer than 0.1 percent of school children are to be found at or above this level. As the I.Q. rises above 160 the frequency of occurrence, of course, decreases. Statistically, cases at or above I.Q. 180 should occur about once in a million times, although they actually occur with somewhat greater frequency. In his classic California study of the gifted, Terman found only 15 children testing as high as I.Q. 180; and Hollingworth reports: "In twenty-three years seeking in New York City and the local metropolitan area I have found only twelve children who test at or above 180 I.Q. (S-B)." It is apparent then, that children who test upwards of Binet I.Q. 160 are extreme deviates in psychometric intelligence and representative of the very brightest children in America.

I have assembled from various scores the case records of 18 Negro children who test above I.Q. 160 on the Stanford-Binet examination. Seven of these cases test above I.Q. 170, 4 above I.Q. 180, and 1 at I.Q. 200. Two of these cases were tested initially by me; the other 16 were reported by psychologists in university centers and public school systems. Analysis of the case records indicates that these children during the early years of their development, at least, manifest the same characteristics as do other very high I.Q. children: originality of expression, creative ability, and surpassing performance in school subjects. Some of these children, but not all, are greatly accelerated in school progress. Two, for example, had completed their high-school course and were regularly enrolled university students at age thirteen; both of these subjects were elected to Phi Beta Kappa and earned the baccalaureate degree at age sixteen.

It is of some significance that all these children were found in Northern or border state cities (New York, Chicago, Washington, and Cincinnati). No Southern Negro child, so far as I have been able to ascertain, has been identified as testing at or above Binet I.Q. 160. It is certain that among the 80 percent of the total Negro population that lives in the Southern states, children with potentiality for such development exist. Whether the fact that no children with this development have been discovered is due to lack of environmental opportunity and stimulation, or merely to lack of identification, is not surely known.

I am not attempting here to show that approximately as many Negro children as white are to be found at the higher levels of psychometric intelligence. There appears little doubt that the number of very bright Negro children is relatively smaller than the number of bright white children in the total American population. Nevertheless, it is apparent that children of very superior psychometric intelligence may be found in many Negro populations, and that the upper limit of the range attained by the extreme deviates is higher than is generally believed.

The performance of extreme deviates at the college and adult levels has not yet been extensively studied. Such evidence as is available, however, indicates that at maturity, as in childhood, some Negroes are to be found at the highest level of psychometric intelligence. In a recent unpublished study conducted at Howard University, it was found that of approximately 3,500 Negro freshmen entering the College of Liberal Arts over a period of seven years, 101 scored in the upper decile, and 8 in the upper centile (national norms) on the American Council on Education Psychological Examination. In a more extensive study, the National Survey of Higher Education of Negroes, there were, among 3,684 students in twenty-seven Negro institutions of higher education located chiefly in the Southern states, 23 cases in the upper decile and 4 in the upper centile on the A.C.E. Psychological Examination. It is of some significance that in the same study 12 upper decile cases are reported among the 105

Negro students in two Northern universities (almost half as many as were found altogether among the 3,684 students in the twenty-seven Negro colleges). This contrast is in accord with the general but undocumented opinion that among Negro college students there are proportionately fewer extreme deviates in psychometric intelligence in the Southern segregated colleges than in the Northern nonsegregated institutions.

The Army General Classification Test data assembled during World War II have not yet become fully available. One may predict with a fair degree of confidence, however, that these data will reveal some Negro cases at the very highest levels of performance. In view of the fact, however, that the Negro selectees were predominantly from communities that provide inadequate provision for the educational and cultural development of Negroes, we may expect that a very small proportion of the total population will be found at the higher levels of performance. Subgroups which have had a normal cultural opportunity should, in accordance with our hypothesis, yield an appreciable proportion of superior deviates.

The findings of the studies cited in this article support the hypothesis formulated at the outset. In some population groups there is to be found a "normal" proportion of Negro subjects of very superior psychometric intelligence, and the extreme deviates reach the upper limits attained by white subjects. Although the incidence of superior cases is much lower among Negroes than whites, a phenomenon which might well be accounted for by differential environmental factors, we may conclude that race per se (at least as it is represented in the American Negro) is not a limiting factor in psychometric intelligence.

The abstract mental tests that contribute to psychometric intelligence do not measure the factors of personality and motivation that largely determine success in life. The findings of studies of gifted children, especially those of Terman, Hollingworth, and Witty, indicate that the highly gifted child usually fulfils his early promise. But not always. Failure among the gifted is also frequent.

The data of this article bring into sharp focus the limitations that our society places on the development of the highly gifted Negro. These superior deviates are nurtured in a culture in which racial inferiority of the Negro is a basic assumption. Consequently, they will typically experience throughout their lives educational, social, and occupational restrictions that must inevitably affect motivation and achievement. The unanswered question relative to the influence of this factor on the adult achievement of superior Negroes is a problem for future investigators to solve.

DE SPIRITI, OR HISTORY IS RIGHT

JOSEPH HIRSH

Recently appointed acting director of The Research Council on Problems of Alcohol, Mr. Hirsh was given a leave of absence from that post to become director of public information for the World Health Organization of the UN; in that capacity he went to Geneva last January to participate in the Fifth Session of its Interim Commission. The article below will form part of a chapter in his book on the problem drinker, to be published this year by Duell, Sloan and Pearce.

MEN have been judged by the company they keep, by the books they read, by the clothes they wear, even—and often—by the women they marry; and if the current rash of writings—the books, the scholarly and popular articles—the radio talks, the speeches and conferences, are any index, by the liquor they drink. They are judged not only *if* they drink but by what they drink.

The abstainers hold, as they have always held, with the Old Testament's judgment that "There is death in the pot," that "A drunkard in the gutter is just where he ought to be," and that all alcohol—except possibly methyl alcohol—is "the devil's brew." Against a background of stately mansions, teardrop limousines, and tailored executives, the distillers pose their bottled brands and make their judgments in terms of "Those Who Know" and "Men of Distinction." And, finally, there are the users themselves, who generally hold that all alcohol (and an injudicious few include the methyl variety), in the words of Alexander Pope, induces "the feast of reason and the flow of soul."

In the center of these humorless judgments and counterjudgments, and of the inevitable controversy concerning prohibition, stands a small group of serious souls, the scientists (hereinafter referred to as The Triple S's; in no way to be confused with the American Association for the Advancement of Science, or The Triple A-S), who in their own inimitable way are also judging their fellowmen and their fellow-drinkers. But theirs is judgment based on scientific inquiry.

The simplicity of their questions belies the complexity of their task. Why, they ask, do men drink? Why do some—not all—become problem drinkers? How can we treat them? How can we prevent alcoholism? What is alcoholism anyway? Is there more than one type? And so on. Their task would be so much easier if they but lived by Cicero's counsel in *De Oratore* (II)—"Not to know what happened before one was born is always to be a child"—if they but turned to a study of history.

Although the great preoccupations of history are to determine "which came earlier" and "who did it first," in this *very* short history of drinking we are less concerned with these facets and more with the facts of problem drinking. The history of drinking is important less because of its medical, social, and religious prohibitions—usually directed at excesses only—than because from the beginning of the record attempts have been made to understand the nature and process of these excesses.

De spiriti, history may not have many of the answers, but with tongue in cheek it has much to teach. Take, for example the question "Why do men drink?" While our psychiatrists probe deep into the psyche, into the id, the ego, and the superego (naturally, I mean the Freudian psychiatrists) and The Triple S's search for "trigger mechanisms," a characteristically alcoholic cellular metabolism, or something awry with our enzymes, Thomas Love Peacock neatly packaged the answer 130 years ago in *Melincourt* (XVI). "There are," he said, "two reasons for drinking: one is when you are thirsty, to cure it; the other, when you are not thirsty, to prevent it."

The Bible records literally scores of references to drinking and excesses, serving as the touchstone for many judgments, critical and valued, that have achieved great currency. One of the earliest references is contained in

the story of the amphibious Operation Noah. Upon alighting from the Ark, we are told, Noah immediately planted a vineyard, made wine, and got drunk. After 377 days and nights aboard ship he doubtless had sufficient reason for attempting to relieve what must have been one headache—by acquiring another.

Escapism, a popular modern explanation for drinking, was likewise reported in this same source book, some 350 years B.C. by an unknown scientist in Proverbs (XXXI, 7), who said: "Let him drink, and forget his poverty, and remember his misery no more." Although psychiatry as a medical science and art was not known until recent times, the ancient Roman dictum *in vino veritas* reveals a knowledge of the subconscious. The Romans saw the lid of the mind lifted by alcohol and the hidden things—thwarted ambitions, fears and frustrations, and the true self—laid bare.

History records as many fictions as facts about alcohol. Prometheus, beset by a vulture that preyed on his liver as a punishment for stealing fire from heaven, supplies one of the earliest symbols of the cirrhotic liver and the beginning of the modern myth that alcohol is responsible for that pathology. This myth has been perpetuated through more than 2,000 years of medical and social writings up to our own time, when the critical Triple S's have tackled the problem without hesitation.

Incredible amounts of time are spent pondering the true nature of the alcoholic in an attempt to classify him. But the guides are there for anyone to see. In 1592 Thomas Nash wrote in *Pierce Penilesse*:

> Nor have we one or two kinds of drunkards only, but eight kinds. The first is ape drunk, and he leaps, and sings, and hollows, and danceth for the heavens: the second is lion drunk, and he flings the pots about the house, calls his hostess whore, breaks the glass windows with his dagger, and is apt to quarrel with any man that speaks to him the third is swine drunk, heavy, lumpish, and sleepy, and cries for a little more drink, and a few more clothes: the fourth is sheep drunk, wise in his own conceit, when he cannot bring forth a right word: the fifth is maudlin drunk, when a fellow will weep for kindness in the midst of his ale, and kiss you, saying; By God, Captain, I love thee, go thy ways, thou dost not think so often of me as I do of thee; I would (if it pleased God) could I not love thee so well as I do, and then he puts his finger in his eye, and cries: the sixth is martin drunk, when a man is drunk and drinks himself sober ere he stir: the seventh is goat drunk, when in his drunkeness he hath his mind but on lechery: the eighth is fox drunk, when he is crafty drunk, as many of the Dutch men be, will never bargain but when they are drunk.

Nash in his own right drew heavily upon Hebrew, Hindu, and Arab legends. The explanation of the atavism of the alcoholic and of his association with sin was popularly ascribed in the days of Nash to the planting of the first vine. The devil, it was said, sprinkled the soil with the blood of monkeys, lions, pigs, and other animals. Their characteristics, in turn, were transmitted to the juice of the grape. Anyway, that's how the story goes.

The Triple S's may think they know all there is to know of the aphrodisiac qualities of alcohol in the most modern physiologic and psychologic terms, but no more comprehensive statement has been written on the subject since Shakespeare wrote in *Macbeth* (II): "Lechery, sir, it provokes and unprovokes; it provokes the desire, but it takes away the performance: therefore much drink may be said to be an equivocator with lechery."

The Russian physiologist Pavlov is best remembered for his bell-ringing, dog-salivating, conditioned-reflex experiments. A few years after Professor Pavlov published the results of his experiments, an Englishman, Dr. John Y. Dent, adapted this principle to the treatment of alcoholism. Using the drug apomorphine, which stimulates the vomiting center of the brain, he gave his patient a full glass of whisky immediately before the drug took effect. Within a matter of seconds, the whisky, much to the surprise of the patient, was returned almost in its original form, though not to its original container. This procedure was repeated at four-hour intervals until the victim was completely conditioned and refused to accept any alcoholic beverages.

If Dent and his followers had only read their history. . . For way back in the second century, Galen, the famous Greco-Roman physician, put live eels in wine and made the alcoholic drink it. This principle was

modified variously, from time to time, involving earthworms and other miniscule, wiggling forms of "pink elephants," up until the eighteenth century. From all reports, this therapy was no less revulsive nor more effective than the modern use of apomorphine or emetine.

Our own Benjamin Rush, physician-general for a time to the Continental Army, the first professor of chemistry in America, and later professor of medicine at the University of Pennsylvania, wrote on the conditioned-reflex treatment. His essay, *An Inquiry Into The Effects of Ardent Spirits Upon The Human Body* (1785), a curious admixture of good medicine, sound common sense, and classic temperance preachments, is noteworthy, on the one hand, as one of the first scientific documents defining problem drinking as a medical problem and advocating the use of conditioned-reflex treatment as one modality. He said:

> The association of the idea of ardent spirits, with a painful or disagreeable impression upon some part of the body, has sometimes cured the love of strong drink. I once tempted a negro man, who was habitually fond of ardent spirits, to drink some rum (which I placed in his way) and in which I had put a few grains of tartar emetic. The tartar sickened and puked him to such a degree, that he supposed himself to be poisoned. I was much gratified by observing he could not bear the sight nor smell of spirits for two years afterwards.

On the other hand, Dr. Rush was responsible for perpetuating a canard that has since become a classic temperance favorite. Writing of a case of a Dr. Haller, he states a "notorious drunkard [was] suddenly destroyed in consequence of the vapour discharged from his stomach by belching, accidentally taking fire by coming in contact with the flame of a candle."

Despite the conditioned-reflex treatment, both modern and classic varieties, The Triple S's are far from satisfied. They might find a lead in another rationale. Milder than Galen's eels is the 1,000-year-old prescription of one of the world's medically great, Abu Ben Mohammed Ibn Zacariya Ar-Razi, known as Rhazes. "Apply vinegar and oil of roses to the head," he said, "and camphor and water to the nose. Employ an emetic, and put the hands and feet into cold water. After a long sleep, prescribe a bath."

If this holds no promise for future clinical research, they might look to Liebault's 341-year-old recommendation in *Maison Rustique*:

> If the Heade complaine itself of too much Drinke, there may be made a Frontlet of Wild Time, Maiden Haire; Roses, or else to drinke of the shavings of Hart's horne with Fountain or River water, or if you see that your stomach be not sicke, thou mayst take of the hair of the Beaste that hath made thee ill, and drink off a good glasse of wine.

Questions of research into the causes of alcoholism, its prevention and treatment, are not the only ones troubling The Triple S's. In spite of themselves, they are periodically drawn out of their dispassionate corners into the prohibition fracas. If they but knew their history, they could provide an answer that would probably satisfy the opposing side in the words of St. John Chrysostom, who said in *Homilies* (I):

> I hear many cry when deplorable excesses happen, "Would there be no wine!" Oh, folly! Oh, madness! Is it the wine that causes this abuse? No. It is the intemperance of those who take an evil delight in it. Cry rather: "Would to God there were no drunkeness, no luxury." If you say, "Would there were no wine" because of the drunkards, then you must say, going on by degrees, "Would there were no steel," because of the murderers, "Would there were no night," because of the thieves, "Would there were no light," because of the informers, and "Would there were no women," because of adultery.

For myself, as I write *De spiriti* here in Manhattan, the big toe of New England, I am convinced that history is right for a jugful of reasons. The Bay Colonists showed good sense in at least one respect, in repealing after seven years, in 1646, one of the most unique prohibition laws in history, directed at drinking "healths." History is right, not merely because in the old days "housewarming" meant the use of "ardent spirits" to achieve that end, but also because Manhattan is said to be a corruption in the Delaware tongue, meaning "Here we got drunk." The historical hospitality of the island has continued from the time of the Henry Hudson swindle to this day.

THE LIBRARY OF CONGRESS AS THE NATIONAL LIBRARY OF SCIENCE

LUTHER H. EVANS

Dr. Evans (Ph.D., Stanford, 1927), the tenth Librarian of Congress, has taught government and political science at Stanford, N.Y.U., Dartmouth, and Princeton. He has served as official adviser to a great variety of cultural organizations, and is on the Executive Committee of UNESCO. Despite the many demands on his time, he was able to complete a comprehensive study of the American administration of the Virgin Islands, published in 1945 as The Virgin Islands from Naval Base to New Deal. *In 1946 Yale University conferred on Dr. Evans the honorary degree of Doctor of Humane Letters.*

IN A letter of September 21, 1814, to his friend Samuel Harrison Smith, Thomas Jefferson spoke of his great collection of books, which was to assume such importance in the history of the Library of Congress, and mentioned that he had spent every free afternoon, while Minister to France, "for a summer or two in examining all the bookstores, turning over every book" and "putting by . . . whatever was rare and valuable in science." His library included, he believed, all that "is chiefly valuable in science and literature, generally." It need not be explained that Jefferson meant the term "science" in a broader sense than systematized knowledge of the physical or material world. It is worth noting, however, that the breadth of his principle of selection has been perpetuated throughout the history of the Library of Congress, with the consequence that the collection of books and periodicals pertaining to the natural sciences and technology has more than kept pace with the growth of the Library's collections in other branches of learning.

A description of the Library of Congress as a closely interrelated complex of special libraries would startle no one who has had occasion to acquaint himself more than superficially with its collections and services, yet the magnitude of the special collections seems to be imperfectly understood. It is not widely known that the Library's stacks contain more than 200,000 volumes in the medical sciences, a collection surpassed in size only by those of the Army Medical Library and the Library of the New York Academy of Medicine; that roughly a million volumes of the total holdings of the Library are classified as belonging to the various disciplines of natural science and technology; that more than 25 percent of the total circulation is concentrated on those subjects. Although many librarians, to say nothing of physicians and other members of the scientific fraternity, might not include the Library of Congress in a listing of great scientific and technical libraries, it is called upon daily to satisfy requests for every possible variety of scientific information from almost every conceivable source. And although there are numerous libraries with a greater concentration of materials in particular scientific disciplines, it is unlikely that any other institution has a diversified scientific collection of comparable scope and quality.

The most important stimulus to the development of this science collection was provided by a happy coincidence of events. The establishment of the Smithsonian Institution in 1846, the appointment of Joseph Henry as first secretary of the institution, a man of vision who immediately upon assuming his office began effecting agreements for the exchange of publications with foreign societies and academies, the lack of space and fireproof storage facilities in the original building of the Smithsonian Institution for the growing Smithsonian library, all led to the transfer to the Library of Congress in 1865 of the extensive Smithsonian collection which by that date had grown to 40,000 volumes. With this body of materials as the nucleus, the Library's scientific collections have grown

with almost incredible rapidity through the decades, as a result of the operations of the Copyright Act, through discriminating purchase, by exchange with institutions in other countries, by transfer from other government agencies, and by gift. Apart from the vast accumulations of monographs, treatises, textbooks, encyclopedias, and sets of journals that one would expect to find, the collections include large numbers of documents which record the investigations of the scientific agencies and the reports of civil and military officers of our own and of foreign governments, as well as captured enemy documents that are being declassified and made public. Well over 50,000 German scientific and industrial reports have been received from the Office of Technical Services of the Commerce Department, and the complete file of more than 30,000 reports on research performed under the auspices of the Office of Scientific Research and Development have been deposited in the Library.

Of the significant smaller specialized collections, that in aeronautics deserves mention. In 1930 the generosity of Harry F. Guggenheim made possible the establishment of the Daniel Guggenheim Fund for Aeronautics in the Library of Congress, which was utilized for the purchase of several famous collections of aeronautic literature—those of Gaston Tissandier, Herman Hoernes, and Victor Silberer. The donation of the collection of the National Aeronautics Association and the deposit by the Smithsonian Institution of the Langley Aeronautical Library swelled the Library's holdings in this field and increased the eminence of the collection. More recently there has been a great influx of documents from the Office of Scientific Research and Development, and the National Advisory Committee for Aeronautics. The Department of the Air Force has been most cooperative and helpful, not only in making available for the Library's collections such of its publications and documents as may be released without danger to security, but also in placing its transportation and other facilities at the disposal of members of the Library staff engaged in the acquisition of aeronautical publications, with the result that the procurement of important aeronautical materials from Brazil and several Western European countries has been greatly facilitated. At present, the Library's collection in aeronautics is second to none in quality, and its file of periodical publications in this field offers a model of completeness yet to be emulated in many of the other disciplines.

Several distinguished special collections of the Library of Congress have been of great value to the historian of science, among them the Henry Carrington Bolton Collection on the history and bibliography of chemistry, the collection of incunabula, 536 of which are classed as "scientific," and the Toner Collection, rich in early American works in science, medicine, and surgery. Finally, the manuscript collections include personal papers of Franklin, Jefferson, Bigelow, Maury, Einstein, and others.

But the scope of the Library's collections in the sciences has not been, and will not be, conducive to lethargy in the Library's officers with regard to the continuing self-imposed assignment of acquiring all important current works in the natural sciences (with the exception of medicine and agriculture) published anywhere in the world. To hope for perfect achievement of this goal would be romantic, of course, but a high degree of success is assured by a well-developed worldwide program of purchasing, by constant negotiations for improved exchange relationships with foreign institutions, and by awareness on the part of all members of the Library's staff in executive positions, including those whose training and interest are remote from the natural sciences, of the pressing importance of the acquisition program in this field. Thus, it seems neither unusual nor especially worthy of comment, to mention one example, that the Library's specialist on India should be concerned with the procurement of materials from the remoter Indian provinces dealing with public-health programs there, or that numerous officers in various branches of the Library should be pondering the problem of collecting and organizing the myriad reports, ephemeral and fragmentary in many cases, which contain the results of the current scientific research

sponsored by the agencies of the Federal government in the vast programs now being conducted.

But the size and quality of the collections assume significance only where efficient techniques are employed in making available for use the information stored on the shelves. It is the artful organization of the collections and the provision of bibliographical aids in their utilization that distinguish a library from a warehouse.

For the small library, simple finding devices are adequate. As the collections grow, however, the complexity of the mechanisms necessary to seek out precisely the publications that will be most helpful to the scholar increases in corresponding ratio. When a library reaches the halfway mark toward the pansophistic goal of comprehending within its collections every publication of importance for the enlightened activity of the Congress and the Federal agencies, and every important publication which reflects the civilization of the United States or of other countries whose civilizations have influenced our own, then the finding devices—the classification schedules, catalogs, and bibliographies—must be developed to the point of almost intolerable expense, and the problem of preventing "loss" of material because of errors in subjecting it to proper catalog control becomes a serious one for the library administrator.

Fortunately, the Library of Congress foresaw early in its history that its classification system would have to permit of almost indefinite expansion to keep step with the advancement of knowledge. Also, it seems to have been understood at an early stage that the collections would become increasingly more encyclopedic as the interests of the government broadened and the demands upon the National Library grew correspondingly diverse. Perhaps this foresightedness sprang from that same faith in human progress which is so characteristic of American political-social thinking, and which has so frequently been a source of amazement to representatives of older, wearier, and more cynical cultures. At any rate, the Library of Congress today is the beneficiary of the sound thinking that went into its system of classification. Essentially, with constant correction and addition, its classification has proved perfectly adequate for the needs of the rapidly expanding collections, and it has proved its merits to the more than two hundred large American and foreign libraries which have adopted it. The fact that this classification scheme is based on a principle of universality, that it attempts to deal with the whole of human knowledge, has not worked to its detriment in respect to the various fields of specialization. The Library's collections in the special fields have been so large as to necessitate expansion of the classification schedules for many branches of learning to a degree that makes them quite adequate for most special libraries. On the other hand, the fact that the Library of Congress does not set itself up as a special library in medicine, or in mechanical engineering, or in metallurgy, or in any other single discipline has prevented it from falling into the error of organizing its materials with a too-specialized viewpoint. It approaches the sciences not merely with the attitude of the physician, let us say, whose interest in current research on the digestion of carbohydrates may be solely in terms of its importance for the treatment of diabetes; it also considers the viewpoint of the organic chemist and the biologist, and, in attempting to find the organizational pattern that reflects a broader logic, seeks also to satisfy the needs of the practitioners of the various specialties through another device, the liberal use of subject headings. And, last, the classification schedules of the Library of Congress have been developed empirically to a great extent, on the basis of the actual books to be classified, not on any theoretical basis or *a priori* reasoning. They are, consequently, hampered by very few rubrics that serve no useful purpose.

It is sometimes charged that certain of the Library's classification schedules have not kept pace with recent developments in the sciences, and there is considerable truth in this allegation. It is inevitable that classification should lag behind scientific thought. At this moment the medical profession is

concerned with the physiological and other medical effects of exposure to radiation from the atomic bomb, and there is a strong likelihood that the corpus of research publication in this field will soon be very extensive. However, the librarian is still somewhat at a loss as to how these publications should be classified, and his decisions will have to await further thinking by the medical profession. But beyond this unavoidable lag, it cannot be gainsaid that the Library of Congress classification schedules in Medicine (*R*) and the auxiliary sciences require accelerated revision and addition. This is not attributable to any failure on the part of the Library administration to realize the necessity of keeping the schedules up to date. It merely reflects the lack of highly specialized manpower in recent years adequate to undertake the necessary revisions and additions. In the main, however, these shortcomings are temporary and will be remedied as rapidly as the budgetary situation permits.

Perhaps the greatest need is for an extensive revision and expansion of the schedule for Medicine. It had been hoped that this expenditure could be avoided through adoption of the medical classification recently prepared for the Army Medical Library. Indeed, the preparation of a classification system for that library, financed by a generous grant from the Rockefeller Foundation, was originally conceived in terms of a revision of the Library of Congress *R* schedule. Early in 1945, however, it became clear that the direction the work was taking would lead to a product far removed in its very structure from the *R* schedule, and misgivings and reservations were expressed at that time as to the likelihood that the Library of Congress would adopt the resultant classification (*W*) for its own purposes. Recently it became imperative that a final decision be reached on this issue and it was reluctantly decided that a change-over from the Library of Congress classification for medicine to that of the Army Medical Library would be ill-advised. Intended for a highly specialized library, the *W* schedule of the Army Medical Library draws rubrics out of their position in the Library of Congress *Q* schedule (Science) for inclusion under Medicine. Considering the encyclopedic nature of the Library of Congress collections and the diversity of interest on the part of the Library's users, it would seem to do violence to logic if this arrangement were adopted. Moreover, the *W* schedule is far more detailed in many respects than is necessary for Library of Congress purposes and would prove cumbersome. Finally, since the *W* schedule represents a totally different approach to the organization of medical knowledge, its adoption would require the reclassification of most of the Library's holdings in Medicine to avoid the endless complications that would ensue if two classification systems were employed for what should be an integrated collection. The work and thought which has gone into the *W* schedule, however, should prove of great value in the expansion and modernization of the *R* schedule, which the Library of Congress hopes to undertake in the near future.

Also proposed for thorough revision as soon as additional specialized professional personnel is available are the Science and Technology schedules, particularly in the areas that have had the greatest growth in recent years.

Interest in the philosophy and techniques of classification and cataloging of scientific material has received a great impetus during the past few years as a result of the tremendously accelerated research programs sponsored by Federal government agencies, the radical alteration in the type of publication resulting from this research, and the dramatic need for bibliographical aids in the utilization of these publications. Before the war the results of scientific research found their way generally into monographic series and into the scientific journals, and the burning questions were the sensible division of subject fields between the learned journals, the making of scientific articles available widely through abstracting and translation services, and the compilation and maintenance on a current basis of bibliographies in specialized fields of research. To be sure, the prewar problems of bibliographical control seemed almost insuperable then, and they have not yet been solved. Nevertheless, the research

chemist of 1939, although he might never be sure that he had acquainted himself with all research findings bearing on any particular problem, could derive some sense of security from the assurance that he had overlooked nothing in the major journals in his field, in *Chemical Abstracts,* and in recent monographic publications.

The major change effected by the advent of the Federal government as the great patron (for practical purposes) of scientific research has been a tremendous proliferation of publications in a previously little-used format, the interim or final, individual report by the contracting research institution reporting its findings to the sponsoring government agency. Another important change has been the increased possibility of needless duplication of effort as a consequence of the fact that several agencies may be sponsoring research along related lines of inquiry for similar or related purposes, each without adequate information as to the results being obtained by the other. In fact, it would be not at all astonishing if occasional research projects sponsored by the very same agency duplicated each other to some extent because of the difficulty of utilizing the reports on the research performed. The governmental coordinators charged with the elimination of just such duplication have long since analyzed the problems involved as falling within the purview of librarianship, and the hunt is on for bibliographical techniques and devices that will bring order into this situation.

Indeed, it has led to an astonishing, heightened interest in classification, cataloging, and indexing on the part of officers of the armed forces and other government agencies responsible for the administration of scientific research programs. It is impossible to estimate the number of man-hours that have gone into parallel efforts by these government officials and their assistants in exploring this terrain. However, the process of self-education involved has not been entirely wasteful. It has led to the conviction on the part of most of them that coordination of such effort would be extremely helpful and that there is more involved in the techniques of classification and in the development of subject headings than is apparent at first glance. In recent months, it has become less common to find cases similar to that of the nonlibrarian who, faced with the problem of classifying the research reports received by his agency, became enthusiastic over the development of an entirely new system of notation by one of his assistants. The distinguishing feature of this new notation, it turned out, was its use of both letters and numbers.

The initial period of interest in the problem of bibliographical control of this material seems to have ended as far as the administrator is concerned. The inclination now seems to be toward acceptance of the thesis that the work of cataloging and indexing these specialized scientific reports had best be left to librarians trained in the natural sciences who would experiment with various established systems of classification, utilize subject-heading lists already in existence as far as possible, and in consultation with the scientific specialists determine the extent to which it was necessary to break new ground.

One of the major difficulties in coordinating efforts toward a joint solution of the cataloging problems involved has been the special interests of the individual governmental bodies in the research. Organization of the reports on the basis of a universal outline of knowledge has seemed to them stodgy and impractical, since their immediate interest is the application of the research results, in many cases, to the problems of military, naval, and aeronautical science, and each group has felt that any system of bibliographical control designed for its purposes should be oriented with its own special interest as the center. It cannot be denied that this point of view does have validity, but the effort to achieve standardization and yet satisfy the demands of all agencies may well prove to be impossible.

The Library of Congress has been consulted frequently in regard to these questions by representatives of governmental agencies concerned with scientific research, and more than a year ago the Office of Naval Research, realizing that a satisfactory answer to its need for control over the thousands of research reports it was receiving could not be derived

without the assistance of an institution devoted to the problems of librarianship, requested the Library of Congress to undertake the work of organizing its research files and to develop a system of classification and of subject headings for this purpose. With considerable breadth of viewpoint, the Navy stipulated that the resultant classification and subject-heading lists should be applicable not only to the reports it was receiving, but also to those of other agencies and, indeed, should serve as a first step toward the establishment of a system of bibliographical control of scientific publications that would be not only sufficiently elastic to withstand the pressure of current demands, but should be attractive to librarians and scientists throughout the country. To these requirements were added others falling well within the purview of librarianship; i.e., the abstracting of reports received, publication and limited distribution of these extracts, and the provision of a reference and bibliographical service to members of the Navy Bureaus and research workers under contract to them.

Supported by a transfer of funds from the Office of Naval Research, this project was begun last spring, and a scientific investigation of the adequacy of various systems of classification and of all known subject-heading lists for the various fields of science is now being conducted.

In September 1947, realizing its obligation as the National Library to assume the leadership in this field of controlling the published results of scientific research sponsored by the government, the Library of Congress called a conference of representatives of twenty-three agencies of the government concerned with similar undertakings. The discussion of mutual problems at that conference was especially helpful to all present, and the willingness—in fact, the urgent desire—on the part of those present to exchange experiences and inquire into the possibility of standardizing procedures and techniques was an extremely hopeful indication that in the course of the next few years a great advance may be expected in the elimination of wasteful effort and the standardization of cataloging and other bibliographical procedures.

It should perhaps be mentioned that one of the provisions of the agreement between the Library of Congress and the Office of Naval Research called upon the Library to investigate the use of mechanical and other technological devices for bibliographical purposes. In the past few years, the imagination not only of librarians and of government officials responsible for research programs, but even of laymen little concerned with questions of bibliographical control, seems to have been stimulated—and in some few instances, inflamed—by the news that rapid-scanning devices were nearing perfection that would enable a library, through electronic as well as mechanical techniques, to peruse literally millions of entries in a short period of time and automatically produce bibliographies of precisely those items in the total collections needed for specific purposes, thus eliminating the complexity and drudgery of the attack upon the Library catalog that must be made under present circumstances each time it becomes necessary to find the publications on a special subject. In addition, there had been the famous article in which Dr. Vannevar Bush allowed his creative imagination free play with the "memex" idea; there had been considerable experiment with techniques of microprint and with the use of punch cards and other rapid-sorting devices in the field of librarianship. Indeed, for some time the Library of Congress had been conducting experiments in the use of IBM equipment for the production of bibliographies, and it was quite conversant with the developments in automatic sorting techniques.

The Science and Technology Project of the Library, which is the unit supported by transfer of funds from the Office of Naval Research, continues to maintain a close watch over progress in the area of automatic aids, but it has been necessary from time to time to point out to enthusiasts that all automatic devices thus far devised or envisioned can give back in the form of selective or comprehensive listings only the material put into them, and that the relationships between the individual bibliographic entities offer the same basic problems of indexing and cataloging. No such device, immeasurably though

it may speed the process of finding the reference desired, will substitute for the experience and the intelligence of the cataloger in the initial stages.

By virtue of its responsibility—a responsibility imposed upon no other library—to maintain a collection and a staff adequate for the research and reference demands of not only the Congress and the Executive and Judicial agencies of the Government, but of the private scholars, the research institutions, and the private citizens of the United States, the Library feels that it is justified in considering itself as the National Library of Science as well as the National Library generally. If one considers that it already possesses collections of publications and other materials in the disciplines of natural science comparable to, if not more comprehensive than, any other collection in existence, the likelihood that this claim can be challenged is small indeed. It should be borne in mind that to function as the National Library of Science, the collections must be extremely extensive in fields important not merely for laboratory research but for the administration of scientific programs, for legislation affecting the progress and sponsorship of science, for scholarship and research in those areas that reflect the constant interplay between the advancement of science and the other elements in national cultures. Perhaps as never before it is important to have information available on the cultural lags in various parts of the world which offer an impediment to the social, economic, and political progress that can follow in the wake of enlightened application of scientific findings. For any library to be a national library of science, its collections must be a great treasury of information in almost all branches of knowledge. They must contain the complete sets of documents of governmental, learned, and other institutions, the proceedings of parliaments, and the official publications of all countries. It would not suffice to have merely every last scrap of publication that can be classified directly as pertaining to natural science.

Where it has seemed advisable to share this national responsibility, the Library has done so. Thus, as long as the Library of the Department of Agriculture and the Army Medical Library continue to maintain adequate collections in their respective fields and to discharge the national responsibility for research library service at a high level, the Library of Congress will not purchase extensively in the fields of agriculture and medicine, but will limit itself to the works that are necessary to maintain a thoroughly encyclopedic collection.

The ideal which the Library of Congress has set for itself as the National Library of Science and the limitations imposed by budgetary considerations upon the service which it is at present able to give are quite disparate. For one thing, the Library of Congress has never possessed sufficient staff trained in the sciences to perform adequately the function of mediation between its collections and the users of the Library; nor has it had the personnel competent to work steadily in the selection of needed materials for the strengthening of its scientific collections. Finally, it has in the past lacked the staff to concern itself as fully as it should have with the problems of the cataloging and organization of scientific materials.

In order to interpret the materials it already has and recommend the acquisition of those it needs, in order to perform a reference service and develop a bibliographical program in keeping with its duty to the laboratory, the school, and to industry, the Library of Congress recommended to Congress a year ago that it should have a division of Science and Technology staffed by approximately fourteen subject specialists and twenty-one expert bibliographers, together with secretarial and clerical assistants, all together a total of more than forty people whose subject knowledge would comprehend geology; metallurgy; astronomy and mathematics, including statistics; nuclear physics; industrial physics, including optics, acoustics, and heat; organic chemistry and biochemistry; physical chemistry, including analytical, colloidal, and nuclear chemistry; chemical engineering; civil and structural engineering; mechanical engineering; electronics and electrical engineering; botany; morphological

zoology, including comparative anatomy, cytology, histology, protozoology, and taxonomy; functional biology, including general and comparative physiology of plants and animals, physiological chemistry, biophysics, zymology, nutrition, and perhaps viruses, bacteriophages, germicides, antibiotics, vitamins, and bioassay techniques.

Beyond the requirements of personnel, there is the need for additional facilities that would make it possible for groups of investigators from the agencies of the government to be stationed at the Library and provided with office and other space, in order that they might work with the collections directly and most conveniently. As matters stand, the collections available are infinitely better than the space facilities for their exploitation by such research workers. Furthermore, there should be space and staff sufficient to permit the establishment of abstracting and bibliographical services based on the already existing collections and the current receipts of materials.

From time to time it has been apparent to other agencies of the government and to other libraries that the Library of Congress was best equipped to undertake certain operations of national significance in keeping with its scientific program, and they have found it advisable to support such projects financially.

The Science and Technology Project undertaken on behalf of the Office of Naval Research has already been mentioned. Recently, the Library undertook the distribution of the scientific reports of the Office of Scientific Research and Development for that agency. It was felt, after the termination of the war, that much of the research performed under contract with the OSRD could be made public without danger to national security. Many of the reports had been reproduced in multiple copies, and it was decided to make them accessible to as wide a public as possible by distribution of these copies to libraries. In April 1946, the Library, utilizing transferred funds, began the distribution of these reports to ninety selected libraries. More than 165,000 copies, representing 30,000-35,000 titles, were sent out.

In cooperation with the Commerce Department, the Library's Photoduplication Service has distributed at low cost tens of thousands of copies of German scientific and industrial documents in microfilm or photostat form. These reports had been filmed by the Office of Technical Services in Germany and stored, for the most part, with the Library of Congress. Their availability has been of tremendous advantage to scientific laboratories, industrial organizations, libraries, and individuals throughout the country.

The Library's cooperative acquisitions program, conducted in Western Europe with the support and on behalf of the nation's research libraries to provide copies of the publications of the war years that had not been available to them, has brought into the country a vast accumulation of scientific as well as other publications. Approximately 1,324,000 individual items have been distributed and are now at the disposal of the research worker.

In short, whenever it has been asked to render national bibliographical services within its purview and its technical competence and to the extent that support therefor has been forthcoming, the Library has undertaken to fill the need. There is sufficient evidence of the logic behind the Library's assumption that there exists a constant demand for the services which only a national library can provide, on the basis of a thoroughly comprehensive collection of materials through the employment of the technical skills developed over a century and a half, and stimulated by a feeling of responsibility to make its facilities, collections, and experience widely available for the national benefit. To the extent that its resources permit, it will continue in the endeavor to devise ways and means of improving its services to science.

THE UTILIZATION OF SCIENTIFIC KNOWLEDGE

J. W. PERRY

Mr. Perry took his S.M. at M.I.T. in chemical engineering in 1931, and then spent a year in Germany as an exchange student. He has been on the research staff of Allied Chemical and Dye Corporation and the Ballistics Research Laboratory at Aberdeen Proving Ground, where he did exploratory work on explosives, particularly rocket propellants. Since 1945 he has been at M.I.T. developing methods for using mechanical and electronic devices in correlating chemical information and in searching files. Mr. Perry is also working on two books: "Chemical Russian, Self-Taught" and "An Introduction to Scientific Russian."

SHIRKING boring tasks is a deeply ingrained human trait. This urge to avoid the tedious, though often called laziness, has motivated the invention and development of the highly efficient machinery characteristic of our modern world. Chemists—being human—dislike time-consuming, monotonous tasks. Perhaps the most distasteful of these is the job of literature searching, the task of hunting for what other chemists may have done in the field of interest. At first glance it might seem that this task cannot possibly be mechanized. Yet patterns of holes in cardboard (or transparent spots in films or magnetic spots on steel tape) can be used to convey intelligence. Such patterns can be sensed by mechanical fingers, electric eyes, etc., and impulses so generated can be compared with other patterns and sorting operations effected. These newer techniques for manipulating information appear capable of advantageously supplementing existing methods of abstracting and indexing.

CHEMISTRY has been defined as the science of the transformations that matter undergoes and the energy changes that accompany such transformations. In line with this definition, chemists are interested, first of all, in the various individual substances considered either as starting materials or end products of chemical transformations. As the result of much work, the molecular structures of a very large number of individual compounds have been investigated in great detail, and the relative position of the bonds between component atoms have been learned with precision for even complicated molecules. These facts are recorded faithfully in the shorthand of chemistry as structural formulas. Structural formulas, however, have their limitations. Although in theory it may eventually be possible to deduce all the properties of compounds from their molecular structures, this cannot be done at present. Hence, structural formulas cannot serve as a basis for so extensive a correlation of properties, phenomena, and concepts as do the symbols of mathematics or the definitional equations of electrical engineering. Structural formulas, nevertheless, do furnish a cohesive pattern in terms of which chemists think when considering not only the architecture of molecules, but also their properties. Consequently, in spite of the fact that not all chemical facts can be deduced from structural formulas, these formulas must be accorded a position of great importance in considering chemical information problems. It is equally true that such problems cannot be dealt with satisfactorily by limiting consideration to structural formulas alone.

Although the energy changes accompanying many chemical transformations are known with the same high precision as the structural formulas of many compounds, the field of chemical kinetics is by no means exhaustively described, or even dominated, by thermodynamics. It would be difficult to make clear to a nonchemist the degree to which chemists in general, and organic chemists in particular, are guided by precepts of a nonmathematical or even intuitive nature. This does not mean that a highly skilled chemist can afford to neglect thermodynamic considerations, but it

does mean that success in his efforts is often the result of an intuitive feeling for his subject that can scarcely be described as other than that of an artist.

This combination of mathematical precision, as exemplified by structural formulas and thermodynamic measurements, with a more elusive quality requiring an intuitive approach gives the field of chemistry a peculiar character and charm.

From the foregoing, it is perhaps apparent that in indexing or classifying chemical literature one is confronted with three types of concepts: structural formulas, which by their very nature partake of a high degree of precision, since such formulas define certain precise relationships between each of the individual component atoms of molecules; concepts, such as those of thermodynamics, capable of mathematical definitions; and nonmathematical concepts, whose definition inevitably must involve problems in semantics.

The very nature of chemical information is such that the papers dealing with new results in the field inevitably must be rather long if valuable detail is not to be lost. This fact, coupled with the extensiveness of the chemical literature, has led to the development of a means for enabling chemists quickly to examine the essential features of extensive accumulations of information without the necessity of laboriously reviewing masses of detail. This method is the preparation of abstracts or summaries, of which there are two types. One mode of abstracting or summarizing the literature prepares a separate abstract for each paper, patent, or similar publication as it appears in the periodical literature. Abstracts of this type have been published for many years by various periodicals, of which *Chemical Abstracts, Chemisches Zentralblatt,* and *British Abstracts* are widely known and used. The other type of abstract summarizes information relating to a single compound, no matter how widely such information may be scattered through different publications. This latter type of abstract has formed the basis of the great German compendia *Beilsteins Handbuch der organischen Chemie* and *Gmelins Handbuch der anorganischen Chemie.* Both types of abstracts have proved their value, and chemists would be very badly handicapped in their work if either type were to be discontinued.

Useful as these two types of abstracts have been in decreasing the number of words a chemist must read in order to search out information, still more help is needed, since the abstracts themselves fill many volumes. It is necessary to provide some means that will enable a chemist quickly to locate those abstracts in which he is interested. Two different methods have been used to provide pathways to abstracts of interest. One method is the classification of abstracts according to their subject matter. This has proved particularly useful with those abstracts prepared in such a way as to be reasonably homogenous with respect to their content, as, for instance, abstracts of the Beilstein or Gmelin type, which refer essentially to single substances. Thus, for example, Beilstein groups the abstracts according to certain features of the structural formulas of the compounds being considered. Such grouping of abstracts has two useful effects. One is to assign to an abstract dealing with a given compound a place in the system which is fixed in relation to abstracts dealing with other compounds. The other effect is to group together on adjacent pages abstracts dealing with related compounds. It is impossible, however, for the Beilstein system, or, for that matter, any classification system, to provide for all the possible groupings of the compounds. As a consequence, it often happens that a chemist is interested in a particular group of compounds the summarizing abstracts for which are scattered through many pages and volumes of the Beilstein compendia.

Abstracts reporting the content of individual papers rather than summarizing information on individual substances cannot usually be arranged so accurately or advantageously within the framework of a detailed classification scheme. At present, abstract journals covering the entire field of chemistry do not undertake detailed classification of abstracts. Rather, the abstracts are classified into a small number of general classes and cross references provided for the relatively few abstracts pertaining to more than one

general class. If detailed classification of such abstracts were attempted, it would be necessary to enter the majority of them under several different headings in the detailed classification scheme. The resulting necessity to provide and also to use a multiplicity of cross references renders such detailed classification of abstracts impracticable.

Since abstracts of the type published by *Chemical Abstracts, Chemisches Zentralblatt,* and other abstract periodicals do not adapt themselves well to detailed classification, another method has been developed for providing leads to such abstracts. This other method is subject indexing, which takes note of those individual aspects or features of each information item of interest to chemists. In indexing abstracts, attention is devoted quite naturally to the specific substances, phenomena, facts, and theories with which the abstract and its parent paper are concerned. Unless a given publication is specifically concerned with general concepts and broad principles, the latter do not form the basis of index entries.[1] For these reasons, subject indexing, as now practiced, does not as a general rule record relationships between individual compounds, phenomena, facts, and theories, on the one hand, and the generic groups and broad concepts on the other. Working out such relationships between the specific and the general is left as a task for the user of the index. Thus, for example, subject indexing as now practiced does not group all olefins under the index heading "olefins."

In considering this problem, another point should be noted. If conventional methods of printing indexes in book form are to be used, then it would be impractical to prepare indexes that would group specific entries pertaining to individual compounds, facts, etc. under generic and subgeneric headings. Moreover, if such indexes were prepared, they would be so bulky that they would fill many volumes and thus prove not only intolerably expensive to publish, but also so awkward and time-consuming in use as to run serious danger of defeating their own purpose.

It should also be noted that the collection of information relating to questions of narrow scope can be accomplished reasonably well by using existing indexes, aside from the not inconsiderable time and effort involved in handling bound volumes, making notes, etc. The situation is, however, less favorable when searching for information pertinent to an inquiry of generic scope. In conducting such searches, the user of the index is forced to look under a multiplicity of headings, with the expenditure of a great deal of time. His problem becomes even more difficult if his scope of inquiry is defined in terms of two or more general concepts. In such a case, it is necessary to search through a large number of index entries relating to one general concept, repeat the same general procedure for the additional concept or concepts, and then attempt to find as best he can those references that deal with the several defining concepts simultaneously. In other words, subject indexing proves an inefficient method for obtaining answers to generic questions, although in general it serves excellently as a means for finding answers to questions of narrow scope.

THIS brief discussion of the two types of abstracts should suffice to indicate the need for developing improved methods for answering questions of generic scope when using large collections of either of the two types of abstracts mentioned. This need for developing improved methods for selecting desired items of information from large collections of chemical information constitutes one of the most promising possible uses of punched cards and similar devices in the chemical information field. Various problems connected with this possibility of applying punched cards and related mechanical techniques are being studied by the Punched-Card Committee of the American Chemical Society. Consideration is also being given to other possibilities of applying such mechanical techniques so as to render published chemical information more easily and more quickly available.

During recent years the experience of a large number of scientific workers, both in chemistry and in other fields, has demonstrated that punched-card methods can be used to very good advantage in managing

small files of information.[2] When used for this purpose, the various items of information are entered on individual cards, and the attributes characterizing such items are indicated by appropriate punching of the cards. In this way, it becomes possible to use mechanical devices to sort the file conveniently and quickly on the basis of any one attribute. For hand sorting, a very simple device may be used, such as a knitting needle mounted on a handle. For fully automatic sorting, complex machinery is required. The results obtained to date, particularly with relatively small hand-sorted files of information, have been so satisfactory that the American Chemical Society is supporting investigation of means of improving and extending the use of punched cards and similar devices in coping with problems posed by the chemical literature.

The question as to whether it would be possible and practicable to use punched cards or similar devices for handling files of information embracing the entire field of chemistry constitutes a challenging problem, requiring unusually careful study. It appears likely that such an adaptation of punched cards or related devices will involve the establishment of new methods for analyzing chemical information and also chemical concepts so as to permit their manipulation to best advantage. Such an analysis of information is a prerequisite to making it amenable to manipulation by machines which are caused to operate not by ideas, but rather by various physical means, such as holes in a card or magnetic spots on a steel tape, coded to represent ideas. Development of coding schemes for molecular structure constitutes the principal progress made in this respect to date. Here, the work of Dr. G. M. Dyson has been outstanding. Thanks to his efforts, there now exists a method for translating molecular structural formulas into a linear set of symbols consisting of letters, digits, and punctuation marks.[3] The Dyson symbolism represents the full details of molecular structure and is also amenable to handling on punched cards. Unfortunately, existing types of automatic equipment cannot handle the Dyson code to good advantage. This is scarcely surprising, since such equipment was designed and developed primarily for manipulating figures in bookkeeping operations.

The problem of developing a comprehensive punched-card code for chemical terminology other than that expressible in terms of molecular structure is being studied by the Punched-Card Committee. Work now under way is directed toward developing new methods for correlating the operations of indexing, classifying, and coding chemical information. Such work involves problems in semantics, logic, and the structure of language. It is hoped that a careful study of chemical concepts and related terminology may make it possible to build up an expansible network of relationships that will greatly increase the degree of usefulness of existing indexing methods. More specifically, it is hoped that establishment of relationships between specific and generic concepts and terminology will permit information indexed in terms of specific headings to be located readily when searching is conducted from a generic point of view. If this can be accomplished, it will be important not only with regard to locating information, but also with respect to analyzing information, establishing cause-and-effect relationships, etc. Such an approach to the chemical information problem appears to be the one that will utilize punched cards and similar sensing and sorting devices to best advantage.

Of more than usual interest in connection with these future possibilities is the recent demonstration by the Classification Division of the U. S. Patent Office that punched cards and accessory equipment can be used very advantageously as tools for facilitating the editing and printing of the usual type of index.[4] In preparing the currently available index to the *Manual of Classification of U. S. Patents,* a file of cards was punched so that, when used to operate a tabulator, successive cards in the file produced successive lines in the finished index. Particularly interesting features of this approach to the problem of preparing indexes are the possibility of cumulating and the ease with which revisions can be made at any time by merely removing, inserting, or rearranging those cards corresponding to the lines to be changed. Arranging the cards alphabetically or in accord with

other orderly schemes can be effected by mechanical sorting devices. When using this method, proofreading consists of checking the accuracy of the punching on the cards; this can be done in various ways, one of which is to use automatic equipment to compare two sets of cards punched by different operators. It would appear, from the experience of the Patent Office, that there is an excellent chance that punched cards can be used to advantage to facilitate editorial work in the preparation of compendia and the publication of periodical abstracts. If such use of punched cards and related devices can be successfully combined with a new approach to the old problem of indexing and classifying chemical information, then there is good reason to hope that considerable improvement can be achieved in existing methods for making published chemical information more readily accessible to chemists.

REFERENCES

1. Crane, E. J., and Bernier, C. L. Indexing Abstracts. *Industr. Eng. Chem.*, April 1948.
2. Ferris, L., Taylor, K., and Perry, J. W. *Bibliography on the Uses of Punched Cards.* Washington: Amer. Chem. Soc. (*J. Documentation*, in press.)
3. Dyson, G. M. Some Applications of the Dysonian Notation for Organic Compounds. *J. Chem. Educ.*, in press.
4. Cochran, S. W. Recent Progress in Patent Classification. Presented at the meeting of the Division of Chemical Education, American Chemical Society, Atlantic City, N. J., April 14–18, 1947.

TWO SQUARES OF GLASS

Two squares of glass,
A purple and a blue,
Light my carrell;
And bring to grey stone walls
A brilliant hue
Of dreams not found in books.

Did some old monk
Immured with vellum tome
Find life too grey,
Reflected skies too few,
And add two squares of glass,
A purple and a blue?

Emily Ericsson

INTERNATIONAL CULTURAL COOPERATION

DAN MABRY LACY

Mr. Lacy (M.A., North Carolina, 1935) was recently appointed Assistant Director for Acquisitions of the Processing Department, Library of Congress. He was formerly Assistant Archivist of the United States and a member of the Committee on Conservation of Cultural Resources.

IT IS natural that scientists should from the beginning have taken the lead in programs for the international exchange of publications. As the Frenchman Alexander Vattemare, himself an amateur scientist, emphasized in a memorial presented to Congress on February 5, 1840:

> Science overleaps the boundaries which political systems interpose between nations. All the men consecrated by its worship are brethren. . . . From one end of the world to the other they understand each other's tongue; the discovery of one is the triumph of all; and, thanks to this fraternity, this federal union of intelligence, science is elevated, and daily extends the empire of civilization.

This memorial led directly to a Joint Resolution passed in July 1840 providing the first Congressional authorization for the international exchange of government publications. International exchanges, especially in the field of science, already had a long history in this country, however, having been carried on since early in the century by the American Philosophical Society and the American Academy of Arts and Sciences.

The real foundation of a comprehensive and systematic arrangement for the exchange of scientific and other publications was, however, the achievement of one of America's greatest scientific pioneers, the physicist Joseph Henry, who made such a system one of the cornerstones of his farsighted program for the Smithsonian Institution. The system of scientific exchanges initiated by Henry as the Smithsonian's first secretary has now been in operation for almost exactly a century and has assembled in the Library of Congress, as the beneficiary of the program, an unparalleled collection recording the advance of science in all its aspects throughout the world.

Out of the visions of such lovers of science as Vattemare and the practical work of such scientists as Henry, who realized the crucial importance of the widest international availability of scientific studies, has grown the whole elaborate machinery of international exchange, which now covers all fields of knowledge and all countries on the globe. The multilateral Brussels Convention of 1886, to which nineteen countries have adhered, twenty-six bilateral executive agreements between the United States and other powers, and literally thousands of individual exchange agreements made by the Library of Congress and other American institutions with foreign institutions provide an annual flow of hundreds of thousands of publications between the United States and other nations, enriching scientific endeavor throughout the world.

Scientists were among the principal losers from the disruption of this world-wide network in the recent war. Though scientific research went on at a greatly intensified pace in all countries, the requirements of national security and the cloture of communications with wide areas of the world stopped the free exchange of discoveries. It has been the work of governments, scientific agencies, and libraries since the end of hostilities to fill the gap of the war years and to restore the exchange network to its former efficiency.

These endeavors have met with signal success in making available to American scientists the results of scientific progress in enemy countries during the war years. Readers of THE SCIENTIFIC MONTHLY are undoubtedly familiar with the work of the Office of Technical Services of the Commerce Department in disseminating captured scientific and technical studies, and with the services of the Library of Congress, through the Cooperative Acquisitions Project, in obtaining and

distributing to major American libraries European publications of the war period. Except as governmental censorship still curtains off the results of research affecting the security of the various nations, American scientists again may draw on the achievements of scientists everywhere in forwarding their own researches.

Scientists elsewhere are not so fortunate. Not only did the war cut off their receipts of scientific publications from other countries; its iron progress across their countries disrupted their universities, scattered their colleagues, and destroyed both laboratories and the painfully assembled collections of libraries. In war-torn countries the problems of exchange have not been those merely of filling gaps and restoring normal relations, but of re-creating the bases for scientific endeavor.

American institutions have moved generously to meet this need, acting principally through the medium of the American Book Center for War Devastated Libraries, Incorporated. This nonprofit corporation, representing diverse institutions and educational groups, has received as donations from American libraries or has purchased through donated funds 4,000,000 books and periodical issues, which have been distributed without charge to hundreds of libraries and institutions in thirty-four countries. A very large part of these publications is intended to provide the library basis for the revival of both teaching and research programs in the natural sciences and to make available in the rehabilitation of those countries American advances in such fields as agronomy, engineering, industrial technology, and medicine. In the Latin-American countries, which did not, of course, receive the special aid offered through the American Book Center to war-devastated areas, a special Hispanic Exchange Project, administered by the Library of Congress and financed by the State Department through the medium of the Interdepartmental Committee on Scientific and Cultural Cooperation, has permitted the wide distribution of scientific publications of the war and the postwar period, including studies[1] on subjects such as antimalarial drugs, of particular Latin-American interest.

[1] Shaffer, K. R., and Kipp, L. J. Books—Agents of War and Peace. SM, 64, 5, 428–32.

THE nature of the need the American Book Center was created to meet is now changing. Much of what can be done by mass shipments to replace war-destroyed collections has been done. A more selective program to meet the specific needs of individual institutions and to supply them with technical journals and other current publications is required. At the same time, European institutions are now increasingly prepared to reciprocate by the exchange of their own publications. The program of the American Book Center, established to meet an emergency demand, needs to be converted to serve the permanent function of providing a central focus for the exchange relationships of American institutions with other institutions throughout the world.

To meet this need, there has just been created as a successor to the American Book Center a United States Book Exchange, established as a nonprofit corporation in the District of Columbia, with headquarters in the Library of Congress. It is hoped to draw into its operations and into participation in its direction all major American library and scholarly interests. The temporary directors of this corporation are: Scott Adams, William G. Carr, Leila F. Clark, D. H. Daugherty, Sidney B. Hill, Paul Howard, Dan Lacy, Harry N. Peterson, and Raymund Zwemer.

Though it can draw heavily on the experience of such large-scale cooperative ventures in the exchange and distribution of books as the Cooperative Acquisitions Project, the Hispanic Exchange Project, the Surplus Books for Veterans Project (through which the War Assets Administration, the Veterans Administration, the Federal Works Agency, and the Library of Congress cooperated in the distribution to American institutions of several million surplus textbooks used in the war by educational programs of the Army and Navy), and the American Book Center itself, it will, of course, be necessary for the new United States Book Exchange to develop its program and procedures gradually and experimentally.

Tentatively, it is proposed to accept from

American libraries and other donors duplicates of recent publications of substantial interest in subject fields needed by foreign libraries. Credit will be given American libraries in proportion to the quantity of material supplied for exchange with foreign institutions. These publications will be shipped by the United States Book Exchange to selected foreign libraries on the basis of their capacity to reciprocate by the exchange of their own publications and of any available duplicates from their own collections. Materials received on exchange from the foreign libraries will in turn be redistributed to American libraries, either on the basis of their interest in specified subject categories or on the basis of selections of specific titles from lists of materials received by the USBE. The distribution of materials received on exchange from foreign institutions will be in proportion to each American library's contribution of publications for shipment abroad, though it is not anticipated that this can be on a piece-for-piece basis for some time to come, until the collections of libraries abroad and the publishing activities of foreign scholarly organizations are restored.

It will thus doubtless be necessary to accept one foreign publication in exchange for several American publications. In addition, it will be necessary to make a small service charge to the American libraries participating in the program to help to defray the operating costs of the United States Book Exchange, though efforts will be made to secure other support for its activities in order to reduce the service charge as much as possible. Even though the exchange will be unequal at first, American libraries will still be the gainers. One European or Asiatic publication that a library does need is worth more to it than several duplicates of American publications that it does not need. Moreover, the services of the USBE will relieve American libraries of much work involved in the listing of their duplicates, the circulation of exchange offers, the solicitation of materials on exchange, and the carrying on of extensive correspondence.

The operations undertaken by the USBE itself will be aimed primarily at the relatively large-scale exchange of duplicates and other noncurrent publications. It will be the purpose of the organization insofar as possible to encourage and facilitate the direct exchange of their current serial publications between American and foreign institutions rather than to supersede any existing exchange of this kind or to undertake a permanent program of handling material of this type.

The recent enactment of the Smith-Mundt Bill, extending to the Eastern Hemisphere the Federal government's existing program for cultural cooperation with other countries, affords a further opportunity for the increase of international exchange activities. One of the principles of the legislation is that the State Department shall utilize insofar as possible the services of established nonprofit organizations in carrying out the purposes of the bill, and the USBE will be a logical medium to carry on activities in the international exchange of publications that the government may wish to support under appropriations made to carry out the provisions of the Smith-Mundt Act.

Now more than ever, when the opening up of new fields of scientific research as a result of developments in electronics, nuclear fission, and the use of radioactive elements offers the possibility of revolutionary advances in human well-being and when the destitution in so much of the world cries out for the swift application of the results of scientific progress to the restoration of agriculture, industry, and health, it is a matter of urgent importance to all men everywhere that there be the freest interchange of information about scientific advances and the most widespread pooling of knowledge. The restoration and enlargement and the making more immediately current of the already generations-old system of the interchange of scientific publications, on which so much of the scientific progress of the last century has been based, is one of the cheapest and most effective means by which scientists, librarians, and administrators can contribute to this end.

LIBERAL EDUCATION AND THE PHYSICAL SCIENCES*

H. M. DAVIS

After taking his Ph.D. in physical chemistry at the University of Minnesota in 1934, Dr. Davis took charge of the chemistry department at Itasca Junior College College for two years. In 1936 he went to Pennsylvania State College, where he is now associate professor of metallurgy. Dr. Davis' interests include molecular spectra and constitution and thermodynamics of process metallurgy.

THE extraordinary attention directed to a list of about 110 books, which has been publicized by the unconventional curriculum of St. John's College, Annapolis, Maryland (Mark Van Doren. *Liberal Education.* New York: Henry Holt, 1943. Pp. 150–52), has resulted in considerable discussion among educators as to the actual potentialities of the named books in the education of the contemporary college student. Naturally, opinion is divided. There are those who are sure that within these books lies the perfect passage to the realm of liberal education, whereas others are as firmly convinced that the list was prepared by confirmed classicists out of love of the classics for their own sake—and not from any sober evaluation of their usefulness to living men. Although it is a familiar observation that dissension is not always lessened by argument among the dissidents, this topic of "The Hundred Books" has aroused so much interest that its discussion flourishes. What follows is a segment from one such organized discussion. It is a consideration of a reading list intended to provide an important part of a liberal education in the physical sciences and is divided into three phases: an argument that a liberal education in the physical sciences is legitimate—even desirable; a definition of the type of book which I consider the best aid toward teaching youth the history and the significance of the development of scientific thought; and a listing of certain books well suited to this purpose, with notes on the merits of the individual books.

It would be well to begin by defining "education." To recognize this as a desirable need is somewhat easier than the formulation of the definition itself. Unnumbered persons have striven nobly to establish a concise and acceptable definition of "education." If all the ink and graphite thus expended were gathered together, they would make an awesome smudge. A principal difficulty in the attempt to circumscribe such an idea is that one may merely assemble a series of platitudes of pleasing sound but of little meaning. Nevertheless, with no pretense of writing a definitive expression of the whole concept, I offer as a working basis the following statement *about* education: *It is the gradual, voluntary adjustment of the conscious individual to his physical and spiritual environment through the progressive acquisition of his intellectual and social heritage.* With the spiritual I mean to include all things not physical but of the mind. Note that the educable individual is conscious—not hypnotized. He is free and he proceeds toward his adjustment voluntarily. Further, as the total heritage of man is hardly to be encompassed during the life span of any individual, its acquisition is an endless process.

These ideas appear to be harmonious with a recorded thought of Jacques Barzun which regards education as "a lifelong discipline of the individual by himself, encouraged by reasonable opportunity to lead a good life" (*Teacher in America.* Boston: Little, Brown, 1945. P. 7); and with that of a committee of the British Association for the Advancement of Science which, reporting on a study of postwar university education, stated that ". . . the task of education includes that

* Based on a lecture given January 17, 1945, as No. 4 of the 1944–45 Wednesday Reading Series, The Library, The Pennsylvania State College.

of fitting a person for his environment, spiritual, human, and material . . ." (A.A.A.S. *Bulletin,* March 1945).

Perhaps we can at least agree that the university's objective in this lifelong process should be to send forth a mind beginning to feel at home in its world and moderately well versed in some branch of human learning, but not yet profound in any field. This major endeavor becomes the "control panel" to which other lines of knowledge are strung, and thus it serves as a basis for, and impetus to, continuing self-education. Commonly, the major subject elected is a language, literature, history, or mathematics; but, quite as properly as one of these, the physical sciences may constitute the tower about which the structure of a liberal education is erected. Indeed, Mark Van Doren, reviving the trivium and the quadrivium of the ancients' seven liberal arts, insists that "the liberal arts survive more intact in [the laboratories of the physical sciences] than elsewhere in education today; other studies, studying them, could learn about themselves" (*loc. cit.* P. 136). And Barzun thinks: "There is no doubt whatever about the place of the sciences; they are humanities and they belong in the college curriculum" (*loc. cit.* P. 91).

There are, of course, many undergraduate students who are appalled at any association of the terms "liberal education" and "physical sciences." This attitude is perhaps a product of the popular misconception that liberal education means superficial education. The general acceptance of Van Doren's simple statement that liberal education is complete education (*loc. cit.* P. 12) would be of tremendous value to this country if it accomplished no more than the modification of that superficial attitude toward learning. Actually, it is an acknowledgment of the propriety of including the physical sciences in a liberal-arts curriculum that in many of our universities one can take a baccalaureate degree in the college of arts and sciences with the major in any of the biological or physical sciences. For example, it is often possible to take a Bachelor of *Arts* degree with a major in such a subject as physics. And why not? If the purpose of a liberal education is to improve a man's adjustment to his world and to leave him with a more serene philosophy, it can no more justly omit all learning in the natural sciences than it can avoid the history of mankind or the psychology of human behavior. In an age of radio communication, transoceanic air travel, radar fire control, guided missiles, and fission bombs—and yet an age in which the man in the street still does not understand the ordinary telephone—how can an intelligent person be truly at ease without sufficient understanding of the physical sciences to enable him to interpret and comprehend new inventions and new engineering achievements as they appear? (Perhaps it is enough to ask how, in such an age, *any* person can be truly at ease.) Too few of us have any worth-while knowledge of physics (I include chemistry as a branch of physics). We drive an automobile (because it is nearly foolproof) with little appreciation of the hidden, beautiful mechanism that powers it, and with no conception of the creative thought that went into its development; meanwhile, we demand the family airplane. We listen to a radio receiver whose complex operation is utter magic to us, and we demand the even more complex television. We are a race of lever-twiddlers, button-pushers, and knob-twirlers, enjoying but not comprehending the products of the prodigious technical labors of a comparatively few men. To produce a people who are fitted and *worthy* to live in this age, there is need of a revision in our educational outlook, to the end that the physical sciences shall receive greater attention in the schooling of the representative individual.

SINCE the circumstances (fortunately, perhaps) provide no opportunity for immediate debate, it suits the pragmatic purpose to assume that the desirability of a liberal schooling in the physical sciences is recognized and accepted. Thus we proceed to a consideration of the method of attaining the desired end.

To present the facts and principles of the sciences as they are known today, there is probably no completely satisfactory substitute for laboratory and classroom instruction by able and interested teachers, coupled with the

faithful digestion of up-to-date textbooks that make rigorous use of mathematical examples of those principles. But it is a rare textbook which, while dealing amply with facts and principles, can impart more than a smattering of the history of their discovery and evolution. Hence, such formal courses—unless they be under omniscient teachers with limitless time at their disposal—need to be supplemented and augmented by the reading of the student. Let it be clear at once that it is the purpose of the books to be used in this connection not to make of the student an expert or master in the sciences, but to convey to him the history of the development of those sciences, the biographies and the philosophies of the men whose lives have extended man's scientific horizon, and an awareness of the place of the sciences in modern life.

It is to be doubted that a reading of the science classics themselves will achieve the desired results for any but the most extraordinary undergraduate. Here it is that we part company with the St. John's list insofar as the classics in the physical sciences are concerned. Certainly, the list contains many books of great literary and historic significance. One is impressed, however, by the fact that in the natural sciences it is both deficient and antiquated and, consequently, that its books are undesirable as primary sources of knowledge. The books in the physical sciences, particularly, promise very limited educational effectiveness. Although there was a time when each of these books was in the vanguard of knowledge, the present valid truths in many of them are so diluted with misconceptions that one may reasonably question the wisdom of assigning them to the typical or even to the superior undergraduate. In others, the contents are still reliable, but the difficulty of reading them is prohibitive. For example, without several years of intensive preparation in physics and mathematics at the university level, few persons can extract much of value from the uninterpreted writings of Newton or Maxwell.

If the student essays a direct study of the earlier science classics, he has desperate need also of the capacity for evaluation. Whereas with Newton and Maxwell his understanding will be supremely taxed, when reading Boyle, Huygens, Dalton, Lavoisier, or the like, he must know how to choose between the kernels of truth and the chaff of doubtful import. This the young scholar is not prepared to do. He needs, instead, a commentator who has already sifted the pile and who will point out his cupful of gleanings. The student can admire a scientific ancestor for the valid fragments of truth he occasionally wrote, without also wading through the confusion of many pages of now-useless speculation on many now-meaningless questions, expounded in now-unintelligible terminology.

It is currently argued by thoughtful persons who are considering the problem of civilizing the youth of Germany that the primary source of the difficulties expected in any attempt to revise the viewpoint of the fanatical young Nazis is the fact that they as children were filled with the Nazi doctrines before they were able to distinguish good from evil, the valid from the spurious. Yet the apostles of the St. John's list want to do a similar disservice to young college students by directing them, before they have learned the scientific right and wrong, to read science classics in which there is often to be found a treacherous commingling of wrong and right. The mature scholar who is already secure in his facts will derive pleasure and profit from reading such classics, but it appears unwise to permit immature students to absorb the untruths that mingle with the wisdom in these works.

Lastly, a reading of a book, even if it be understood, is no guarantee of an appreciation of the author or his times. The aspirations and exultations, as well as the struggles and disappointments, of the man are often only poorly revealed in his bare scientific writing. The student needs biography and commentary.

The value of biography may be emphasized by the example of Henry Cavendish. It is interesting enough to read of his experiments on gases and of his clearly reasoned deductions from them, especially his proof of the composition of water and his demonstration, late in the eighteenth century, that air consists of oxygen and nitrogen plus a gaseous

residue of 0.83 percent of the original volume. This residue he cautiously ascribed to experimental error. He also made extensive researches in electricity but never published them, so that it was left to Faraday to rediscover the same results a generation later. The facts alone are interesting. But how fascinating these facts become in the light of contemporary revelations of the amazing timidity and reclusiveness of the wealthy bachelor, and the history of later researches on the atmosphere!

His scientific reticence seems but the parallel of his lifelong shyness. The enormous wealth he had inherited from his father had been augmented by a large legacy from another relative. Provision for the modest wants of his semiascetic existence required less than the accrual on his banked cash, so that the already great fortune continued to grow. Thus, at the end of his life, Cavendish was the wealthiest depositor in the Bank of England. Even so, his banker frequently urged him to invest part of his money in some profitable enterprise (I suppose that then, even as now, time deposits drew no great interest). Ultimately, Cavendish became so annoyed with this insistence that he threatened to withdraw his money from the bank unless the suggestions ceased. In his home, to promote his isolation, this island in an island of islanders had a special servants' stairway constructed so that he might be ensured against the possibility of encountering one of the women servants on the stairs. To avoid meeting his housekeeper face to face, it was his custom to leave money and a note of instructions for her at a designated place in the house. When, at a social gathering, an admiring guest from another land was introduced to Cavendish and gave him a somewhat effusive greeting, the poor fellow became so disconcerted that he suddenly darted out of the group, entered his carriage, and hurried home. Even on his deathbed, when he felt that the end was near, he sent the attending servant out of his sickroom so that he might die as he had lived, alone. Many twentieth-century psychiatrists would doubtless like to have known Henry Cavendish.

For an increased appreciation of the experimental genius of this remarkable recluse, one should read of later studies on the composition of the atmosphere. In his unidentified 0.83 percent residue, Cavendish had narrowly missed the discovery of argon, revealed by Ramsey about 110 years later to constitute 0.94 percent of the air by volume. It seems almost unnecessary to mention that such intimate glimpses of the life and character of a man are hardly to be obtained from purely scientific treatises or reports of investigations, however truth-full and scholarly these may be.

These arguments may be summarized in the following opinion. In general, the best books for the undergraduate who seeks to acquire a background in the history and the philosophy of the physical sciences are not the classic writings *inviolati* of the ancients, nor those of the scientific fathers of the modern period. It is usually far better that the student make his acquaintance with the giants of the past through the biographies and commentaries by modern scholars who have carefully—and often lovingly—interpreted and evaluated the earlier work in the light of present knowledge.

The books listed here are mainly of the type specified. Although some of them cannot be thus classified, but are more in the nature of critical surveys, not one of them is an unassayed classic. They are listed with little attention to chronology, but with some consideration for parallelism with collegiate courses being pursued and the maturity and attainments of the student. Thus the list is intended to follow, in a general way, the progress of the reader from freshman to senior status (a sort of *Reader's Progress*). The last two books are of a rather highly scientific content and are intended to satisfy the needs of readers who have a particular bent toward scholarship in the physical sciences. Probably they could not be read by every student.

Perhaps one should interpose a remark about the inclusion of books concerned with mathematics. Although it may be true that a pure-blooded mathematician is never so happy as when he does not know what he is talking *about,* and although the faithful worshipers of the Goddess of Mathematics insist

that she loses some of her pristine beauty when prostituted to the mundane service of physics or chemistry, nevertheless her protracted intimacy with physics has been so fruitful and is now so universally and shamelessly recognized that I have not hesitated to name a few titles on mathematics in a list of useful works on the physical sciences.

Although I have been quite opinionated in defining the type of book which should be included in such a list, it must be emphasized that in offering the following reading list no claim to perfection or completeness is presented. Other, equally effective, lists could be assembled.

Discovery of the Elements. M. E. WEEKS. *J. Chem. Ed.*, 1939.
Simple, interesting, well illustrated.

Out of the Test Tube. HARRY N. HOLMES. (4th ed.) Emerson, 1943.
Vigorous, graphic accounts of the drama in research and of many of the outstanding contributions of chemistry to modern life. Good companion for Paul de Kruif's *Microbe Hunters* and *Seven Iron Men.*

Creative Chemistry. E. E. SLOSSON. Century, 1920.
Although nearly thirty years old, this is still a fascinating and instructive story of great achievements of the young American chemical industry.

Torch and Crucible. SIDNEY J. FRENCH. Oxford Univ. Press, 1941.
Much the best account of the life and times of Lavoisier known to me. In addition to the excellent record of scientific and biographic facts, there is also a delightful portrayal of the social mores of the period and of Revolutionary politics.

Lives of Men of Letters and Science in the Time of George III. LORD BROUGHAM. Carey & Hart, 1845. (Out of print.)
It is regrettable that this near-contemporary evaluation of a number of outstanding figures in a brilliant period is now so long out of print that it is rare, even in large libraries. Because I have not seen a copy of the book in many years, I cannot recall all its content; but it does give interesting stories of Lavoisier and Priestley, and the best glimpse of Cavendish known to me. One of the best things in the book is the sketch of J. J. Rousseau. I should be happy to see this book reprinted.

Life of Pasteur. R. VALLERY-RADOT. Doubleday, Page, 1923.
Factual, quietly inspiring, this is the best of the Pasteur biographies. If anyone should ask why such a book is in the list, let him remember that Pasteur was primarily a chemist.

Romance of Leonardo da Vinci. DMITRI MEREJKOWSKI. Heritage, 1938.
One of the most rewarding books I ever read. Leonardo's scientific side receives just treatment, along with the artistic. There is a fascinating inquiry into the working of the great mind itself. One of the richest treats is the panorama of Renaissance life that is provided. The conflict between the light of doubt and the shadow of authority is strikingly revealed. There are alchemy and witchcraft; ascetic religious zeal and profound hypocrisy; the glory, the magnanimity, the vices, and the revolting intrigues of petty princes. The pages glow with the personalities of Savonarola, Machiavelli, Raphael, Michelangelo—even the unbelievable Borgias. Magnificently illustrated with sketches and paintings by the incomparable Leonardo himself.

De Re Metallica. GEORGIUS AGRICOLA, 1556. (Translated and profusely annotated by H. C. and L. H. Hoover.) London: *The Mining Magazine*, 1912.
A rare instance in which the translators of an early Latin technical work possessed the understanding necessary to a satisfactory rendition in a modern language. In using Latin, Agricola undertook to record the most advanced chemical-metallurgical technology of his day in a language that had undergone no growth for some ten centuries, and thereby he achieved an obscurity that magnified the task of translation. But Mr. Hoover, an able engineer, succeeded in avoiding the blunders of meaning which nontechnical translators have committed. Moreover, his generous notes (which, in aggregate, must exceed the length of Agricola's text) constitute an authoritative running commentary. Copies of this marvelous book were never abundant, but it is to be found in the better libraries. It would be a splendid service to English-reading students everywhere if someone would make this unique work available in a new edition.

A History of Science, Technology and Philosophy in the 16th and 17th Centuries. A. WOLF. Macmillan, 1935.
A comprehensive work of great breadth and detail, yet sufficiently critical that the young reader need never flounder for the thread of truth. Arranged according to topic, it treats an imposing array of subjects: from astronomy and chemistry to mineral technology, the social sciences, and philosophy. In time, it reaches from da Vinci and Galilei to Leibnitz and Halley. Well illustrated and documented.

A History of Science, Technology, and Philosophy in the 18th Century. A. WOLF. Allen & Unwin, 1938.
A continuation of the above book, built upon the

same plan, and almost equally well done. The great developments in the fundamental sciences and in philosophy, during what the author likes to call "The Age of Enlightenment," are fully and carefully recorded. In keeping with the inventive growth of the period, there is an expanded and vitalized section on mechanical technology. The documentation and illustration of these books leave hardly anything to be desired.

Men of Mathematics. E. T. BELL. Simon & Schuster, 1940.
Biographical and critical essays on the giants of mathematics.

Science Remakes our World. JAMES STOKLEY. Ives Washburn, 1942.
Concerned with technological adaptations of recent advances in chemistry and physics. Chemurgy, explosives, metallurgy, electronics, and illumination are emphasized. An introduction to the physics of the atom leads the reader to the threshold of a revelation of the fission bomb. Illustrated with photographs.

Foibles and Fallacies of Science. D. W. HERING. Van Nostrand, 1924.
A lively and thought-provoking book that will seem timely for a long while, since the man in the street is very slow to relinquish his well-established fallacies and superstitions. Even the advanced student will occasionally discover one of these of which he has not been entirely purged.

Introduction to Modern Physics. (1st ed.) F. K. RICHTMYER. McGraw-Hill, 1928. Chaps. I–III.
A thoroughly enjoyable historical survey of the major developments in physics which led to the emergence of what is known as "modern physics."

The Autobiography of Science. F. R. MOULTON and JUSTUS J. SCHIFFERES. Doubleday, Doran, 1945.
History of scientific progress, told by means of excerpts from the writings of many of the ablest thinkers of the past and present, each selection being prefaced with a helpful explanatory note—often biographical—by the editors. Subjects are rather well balanced, the physical sciences receiving an important share of attention.

The Search for Truth. E. T. BELL. Williams & Wilkins, 1934.
An uninhibited examination of the bases of philosophic thought, with especial attention to mathematics. Critical, occasionally cynical; brilliant, provocative, possibly irritating. Nothing is sacred except truth—and it's hard to tell what that is. Worthy of repeated readings. Out of print, but common in libraries; still frequently to be found at the better secondhand dealers. Surely there is no other book like it. Deserves a reprinting.

Mathematics and the Imagination. KASNER and NEWMAN. Simon & Schuster, 1940.
A very modern presentation of some of the most fascinating topics in mathematics, including mathematical puzzles, chance, and a variety of geometries. It is pleasantly, even vivaciously, written. Stimulating to the imagination; delightfully instructive. By the time the authors are through with him, the reader should have been joyously cleansed of all traces of veneration for Euclid—and perhaps others.

Atomic Energy in Cosmic and Human Life. GEORGE GAMOW. Cambridge Univ. Press or Macmillan, 1946.
The epidemic of books and articles on atomic energy that has scourged the English-reading world since Hiroshima can be forgiven and largely forgotten by the happy reader of this little book. Here, in 160 small pages, a mature authority on atomic physics has set down the physicochemical history (including the revelations of astrophysics), the present status, and the probable future of atomic energy. Professor Gamow's relaxed manner of treating the most complex topics is a reader's assured delight. The already lively discourse is further brightened by a number of half-whimsical drawings by the author. Regrettably, the spritely text is occasionally marred by rough grammar.

The Nature of the Physical World. A. S. EDDINGTON. Cambridge Univ. Press, 1928.
When Professor Eddington wrote "world," he meant what the average literate American calls "universe." Although some have disagreed with Eddington's picture, few have written as lucidly about the organization of that world. No novel, this book should be read studiously. For him who will read it thus, it offers a rich reward.

The Nature of Thermodynamics. P. W. BRIDGMAN. Cambridge Univ. Press, 1941.
This book is unique in that it deals with thermodynamics without the definitive aid of mathematics. Professor Bridgman, apparently aware that thermodynamic understanding is not, *ipso facto,* a possession of all who use thermodynamic equations, has sought to clarify the basic concepts and the fundamental reasoning of the science through the use of words only. The result is worth all the effort that must have gone into it. I am ready for my fourth reading of this ageless book.

THE APPLICATION OF SCIENTIFIC PRINCIPLES TO SCIENTIFIC PUBLICATIONS

ALBERT ELLIS

Dr. Ellis took his Ph.D. in psychology at Columbia University in 1947 and is now a consulting psychologist in New York City. His principal interests include clinical psychology and projective and nonprojective testing. He is working on a book to be entitled "The Nature and Nurture of Human Love."

THE main point of this paper may be expressed in the form of a simple question: When will scientific principles be applied to the publication of scientific articles?

A cursory glance at almost any unabridged dictionary will show that the term *scientific* goes hand in hand with such adjectives as *systematized, classified,* and *exact.* In the areas of social as well as natural science, those who wish to obtain the respect of their co-workers and associates always insist on the use of *standardized* instruments and procedures. All, it would seem, except the editors of scientific publications, who, in the most unsystematic, inexact, and unstandardized manner, blithely continue to turn out their products in a bewilderingly diverse array of almost all possible shapes, forms, sizes, types, and contents.

Take, for example, the important matter of bibliography. Assume that Richard Scientist, a reputable member of the A.A.A.S., has spent some time gathering data for an article to be entitled, let us say, "The Psychobiological and Psychophysical Organization of Social Groups." He has done a thorough job of background research for his article and has enough material for about forty pages of typewritten manuscript; in addition, he has a bibliography of some two hundred items to put into shape for publication.

Since there are a great many scientific periodicals—including those in the field of physics, biology, psychology, sociology, medicine, anthropology, and education—in which Dr. Scientist might have his paper published, he has not quite decided to which one he will submit it. He realizes, moreover, that the journal to which it is first submitted may reject it, even though it is a worthy article, for a number of reasons: because, for example, it may be too lengthy, or of not quite sufficient interest to the publication's specialized readers, or too similar to some other recent inclusions in this publication. Also, he may himself not wish to publish it in a certain periodical if he discovers, from communication with its editor, that its publication time lag is considerable.

Richard Scientist's problem, therefore, is this: In what *form* shall he have his paper typewritten, in view of the fact that it may go the rounds of several scientific publications before it is finally printed? For, although you might think that scientific periodicals, at least, would adhere to a standardized manuscript form, this is far from being the true situation. Thus, magazine A may require that all bibliographical items be alphabetized and consecutively numbered in the manuscript; magazine B, that they be alphabetized but not numbered; magazine C, that they be numbered but not alphabetized. Again, periodical A may insist that bibliographical references be noted in the text of the manuscript by parentheses, like this: (13); whereas periodical B may insist on superscripts, thus:[13] Furthermore, publication A may require bibliographic citations to be collected and typed at the end of the article; publication B may ask that they be typed at the bottom of each page of manuscript, or in the body of the manuscript immediately after the reference is made.

This means, of course, that if Richard Scientist first has the manuscript of his article typed so that the bibliographical citations are made in the manner approved by, say, peri-

odical A, and he eventually has his paper accepted for publication by, say, periodical C, the chances are excellent that the editor of C, on accepting the paper, will return it to Dr. Scientist with a notation to the effect that, before it may be sent to the printer, the manuscript must be completely retyped. Consequently, unless Dr. Scientist is employed by some institution that generously accords him free secretarial service, he must expend considerable time, effort, and possibly money in order to revise his typescript.

Remember, moreover, that Dr. Scientist has a bibliography of some two hundred items for his paper. This alone will normally require at least fifteen typewritten pages. Let us assume that he has decided, hoping for the best, on a given manner of referring to his bibliography: by, say, alphabetizing and numbering it. After the main body of the manuscript has been typed, he now has reached the point of appending the alphabetized and numbered bibliography. But in what *form* shall this bibliography be presented? Periodical A, perhaps, insists on the full name of all authors; periodical B wants only their initials. Publication C requires, for article references, the month and year of publication; publication D requires only the year. Periodical X insists on the complete pagination of articles used in the bibliography; periodical Y insists only on mention of the first page of the articles; periodical Z wants no mention of pagination. Publication A desires the volume number of references put in Roman letters; publication B wants Arabic numerals; publication C dispenses with volume numbers entirely. Periodical R insists that the sequence of citation be date, volume number, pagination; periodical S insists on volume number, pagination, and date sequence; periodical T requires volume number, date, and pagination. Magazine A demands commas as separation points between date, volume, and pagination citations; magazine B requires semicolons; magazine C wants colons; magazine D asks for parentheses. And so on and so forth.

It may be thought that this pointing up of the heterogeneity of bibliographical format in scientific publications is a gross exaggeration of the existing conditions. It may be felt that occasionally, perhaps, some periodicals vary from the one mode of bibliographical format usually prevalent, but that such variation occurs so infrequently as to make this matter hardly worthy of serious consideration. The facts, however, are quite otherwise. To illustrate them empirically, let us suppose that reference No. 15 in Dr. Scientist's article consists of a paper by John Doe on "Man and Life," published in the July 1947 issue of *Scientia* magazine, Volume 3, No. 1, pages 2 to 9. Cursory reference to publications at hand in my personal library shows that, among some thirty-seven scientific publications that might possibly accept Dr. Scientist's article for publication, there are no less than twenty-nine different ways of citing this bibliographical material. Space limitations preclude the listing of all these differing bibliographical models, but here, by way of illustration, are a few of them:

Doe, John. 1947. Man and Life. Scientia, vol. 3, pp. 2–9.
15. Doe, J.; *Scientia;* 1947; 3: 2.
J. Doe, "Man and Life," *Scientia,* 1947, 3, 2–9.
15. Doe, J. Man and life. *Scientia.,* 1947, 3, 2–9.
John Doe, "Man and Life," *Scientia,* Vol. 3, No. 1 (July 1947), pp. 2–9.
15. Doe, John.: *Man and Life.* Scientia., III, 1947, pp. 2–9.

Detailed examination of the thirty-seven publications showed that their approved bibliographical forms of citation differed widely in relation to spacing, alignment, punctuation, italicizing, typography, numeralization, parenthesizing, order of presentation, and inclusion of relevant material.

It must be emphasized that the twenty-nine observed variations on a bibliographical theme were not found after an exhaustive research of contemporary scientific publications. On the contrary, they were all secured from recent publications and reprints at hand. Further research could doubtless triple or quadruple the number of examples. The point, though, is not to find how many such variations actually exist, but to discover some quick and effective method of reducing their number.

Some periodicals—e.g., The Scientific

MONTHLY and the *American Sociological Review*—permit their contributors a certain amount of leeway so far as bibliographical notation is concerned. Thus, in the June 1947 issue of the latter publication, there are at least four different ways of stating similar bibliographical references. Obviously, the *Review* editor did not consider it worth while to insist that all contributors follow precisely the same citation pattern.

This kind of liberal policy toward bibliographical citation, although it unquestionably has certain advantages as far as individual authors are concerned, has outweighing disadvantages that should preclude its general acceptance for scientific presentation. In particular, when the form and content of bibliographical inclusions are left largely to the author's choice, a good many citations are bound to be made in which even the most salient information, including date, volume number, or pagination, are unfortunately omitted. Scientific editors should demand, at the very least, that there be no such omissions.

The question therefore remains: What, as scientists, are the editors of scientific journals going to do about the haphazard, unstandardized, and unscientific state of affairs that now exists in regard to bibliographic citation? The answer seems all too obvious: that, from the present look of things, they are going to do absolutely nothing. There appears to be so little connection, let alone coordination, among even those scientific editors whose publications go to identical or overlapping groups of readers that it seems almost utopian to expect the editors in all fields to organize for some effective action in relation to this problem.

Yet, with a lot of good will and only relatively little effort, help in this area could easily be forthcoming. For the problem is far from being insoluble. It has but two main aspects: first, deciding on what particular form (or perhaps handful of forms) of citation is most advantageous and least disadvantageous to both authors and publishers; and, second, the agreement of virtually all scientific editors to adopt this particular form(s) of citation and make it mandatory for all contributors.

Some of the important points to be considered in adopting a standardized form for bibliographic citation would probably be these:

1. The form adopted should be comprehensive enough to include all important bibliographic material; such as, in the case of citations from periodicals, date of publication, volume number, pagination, and perhaps issue number.

2. It should, at least where an article includes many bibliographical citations, provide for a separate listing at the end of the paper, because such a listing may (a) provide interesting additional reading material for the reader of the article; (b) make all the references in the article quickly accessible at one point; and (c) obviate the author's having to repeat, except by citing the reference number, a single source quoted several times in the same paper.

3. It should be arranged for easy typing. Thus, the text references to the bibliography may consist of parenthesized figures instead of superscripts; and all unnecessary uses of capitalization, italicizing, and bold-face type (which usually cannot be duplicated or are difficult to indicate on the typwriter) may be avoided.

4. The numbering of the references should be arranged in such a manner as to make it easy for the author to insert additional references in later drafts of his paper without his having to renumber the entire bibliography. (One method of doing this is to have the bibliography alphabetized but not numbered; and to have the reference numbers in the text, if any, consist of the date of the bibliographical source cited. Then new sources can easily be inserted into both the text and the bibliographical list at the end of the paper without unduly disturbing the material already typed or printed.)

There are doubtless other considerations than these to be taken into account before any final standardized bibliographical form of citation can be decided upon. But the point is that, through their common membership in an organization like the American Association for the Advancement of Science, or through other channels of communication, the scientific editors of this country (and

other countries, of course) should get together as quickly as possible to discuss this matter, to decide for themselves which standardized bibliographical form they deem best, and then universally to adopt this form for *all* types of scientific publications. Not to do so will be to tolerate a haphazardly developed, multiclassificatory, and obviously unorganized method (or lack of method) that no group of scientists worthy of the name should for a moment consider perpetuating.

So MUCH for the matter of bibliographic standardization. But this, of course, is only one example of the present unscientific state of affairs that exists in relation to scientific periodicals. Equally as good a case could probably be made for, say, the matter of size of publications. For why, indeed, should scientific journals be printed in literally scores of different shapes, sizes, and general formats? In the first place, many scientists collect reprints from a wide variety of journals; and the inconvenience of handling and storing these is in no small measure a result of their diverse sizes. In the second place, individual scientists as well as librarians often have quite a problem finding shelf room for oversized, medium-sized, and undersized publications that should rightfully rest side by side. In the third place, certain large- and small-sized volumes are by no means easy to read, to handle, or to take on a journey. Why, then, all the variation in the size of scientific journals? If the commercial publishers of this country, who have never been accused of being particularly scientific or cooperative, can arrange to print nearly all their catalogues on paper of a uniform size, so that they may be conveniently bound in a yearly edition of the *Publishers Trade List Annual,* surely scientific editors should be able to arrange something equivalent. Perhaps all scientific journals cannot be printed in one optimum-sized form; but surely the number of different sizes could be reduced to a handful.

Let us not belabor the point, however. From what has already been said, it should be obvious that *some* application of scientific principles to scientific publications is sorely needed at present. Exactly at which points this application is most needed, and precisely how it should be accomplished, is hardly for the present author—who is not an editor of any publication—to say. The subject, only the periphery of which has been touched in this article, is broad and highly complex. Every reader of scientific journals has a vital interest, as well as a definite stake, in it. But the ones most concerned are the present editors of the various scientific publications and the organizations that sometimes control the policies of these editors. It is up to these editors and these organizations, if they would adequately measure up to their obligations as scientists and as scientific publishers, to get together for purposes of discussing, planning, and acting to eradicate the existing disgraceful state of affairs: namely, that scientific principles seem to be last and least applied to those publications that ostensibly are trying to do most to further the cause of science.

BOOK REVIEWS

WORLD OF ILLUSION

Magic Shadows. Martin Quigley, Jr. 191 pp. Illus. $3.50. Georgetown Univ. Press. Washington. 1948.

READING this book must be a revelation and a humbling for anyone even remotely connected with motion pictures or, for that matter, for anyone who ever sees a motion picture. For nowhere through this fascinating adventure and success story are any of the familiar names connected with the art or industry, whichever you chose to call it. There is no Gable nor Peck nor Garbo nor Chaplin nor Mayer nor Selznick here. Indeed, with the exception of Edison, there isn't a single name that the layman has heard or that has ever been in lights or drawn a salary or made a gossip column. Yet Kircher and Plateau and Von Uchatius and the Langenheims are actually the gods of the machine who made these other people possible.

And Quigley has made them, in many instances, far more exciting than the shadow children who came after them and owe them their birth. He has traced the invention of motion pictures as far back as man has thought, even to the sun itself, and followed it forward in time through the perils and disappointments, the heartbreaks and elations, the mishaps and the lucky breaks, to the final consummation.

Nowhere does the interest slacken; one reads on and on, fascinated by the steps that seem so natural now, but were so uncertain then, steps that led to the perfection of an art and a machine that we all take perhaps too much for granted.

An immense amount of research must have gone into the book's creation; one has a sense of complete documentation. One also has a feeling of eminent fairness. The reader is sure that Mr. Quigley has carefully weighed every smallest claim of the least contributor to inclusion for credit toward the forward movement of the machine. And one knows that each piece of the jigsaw is in its proper place at last and the puzzle is completed, the picture whole.

This should in no sense be considered a source book or a technical one to be put aside to dip into for leisurely reading. It is an imperative must, not only to the student or the technician but to all readers of adventure stories—adventure into the courage of the human heart and the profundity of the human mind.

JESSE L. LASKY

RKO Studios
Hollywood, California

GENIUS

Whom the Gods Love. The Story of Evariste Galois. Leopold Infeld. ix + 323 pp. $3.50. Whittlesey House. New York. 1948.

THIS is the first full-length biography in English of Evariste Galois (1811–32), who, in the opinion of Sophus Lie, was one of the four men who determined the course of nineteenth-century mathematics, the others being Gauss, Cauchy, and Abel. Galois' mathematics is different in kind from that of his compeers. It minimizes formulas and calculation and deals directly with fundamental concepts.

Professor Infeld balances his account fairly between Galois' two passions, his love for mathematics and his hatred of tyranny. In both, Galois was frustrated. The brutish stupidity of his teachers and the callous obtuseness of academicians all but succeeded in depriving mathematics of one of its greatest glories. The treachery of the police and of friends tricked him into the duel over some brainless nonentity in which he was killed at the age of twenty. All this is simply and movingly elaborated by Professor Infeld. He has one advantage over some of Galois' previous biographers: he is not French, and therefore is not in dishonor bound to wield the whitewash brush.

The book should be required reading for all teachers, academicians, and would-be fosterers of loyalty. There is a sardonic irony in the jest that the reactionary Bourbons of the 1830s, whose crowd did Galois in, should have shed their name on the party for which Galois died. He was a Democrat.

But, as Liouville exclaimed a hundred years ago, "Galois is no more! Let us beware of useless criticisms and look for the merits. . . ." Indeed yes. If Galois were with us today no doubt he would find all teachers competent and sympathetic and all academicians enlightened, and no inquisitor would bedevil him with, "Are you a member of the Democratic Party?"

E. T. Bell

California Institute of Technology
Pasadena

IS MAN FREE?

Ideas Have Consequences. Richard M. Weaver. 190 pp. $2.75. Univ. of Chicago Press. Chicago. 1948.

THE thesis of this book is: The world is intelligible. Man is free. Those consequences of man's actions which we are today expiating are the product not of biological or other necessity, but of unintelligent choices. We see hecatombs of slaughter; entire nations desolated by war; half of mankind looking upon the other half as criminal. Western man has made an evil decision which has become the cause of other evil decisions.

The author is evidently a man of religious convictions, trained in metaphysics, which we used to call philosophy. He dislikes the specialism and "fragmentation" of modern science; he believes that "democracy" has replaced faith and authority and has tried to substitute equalitarianism for the gentleman of high ideals. For these reasons modern civilization has failed.

The author's development of his thesis runs as follows: There is a source of truth higher than man. The denial of everything transcending experience is the denial of truth. There is no knowledge at the level of sensation. Science, the careful study of nature, denies the transcendental and leads men to regard nature as a self-regulating mechanism. Religion, therefore, becomes ambiguous, and man, instead of being divine protagonist in a great drama, becomes merely a wealth-seeking, wealth-consuming animal.

Having asserted this thesis, Mr. Weaver, without pausing to prove it or to concede that it needs proof, launches into a devastating attack upon modern civilization:

> Man becomes a fatalist: his life is practiced without theory; his institutions crumble; wars must be fought, but immersion in matter unfits him to deal with problems of matter.
>
> In the Middle Ages the philosophic doctor was the possessor of the highest learning. He was succeeded by the Gentleman, the idealist. The American South cherished this ideal and gave it fresh strength.
>
> The world today has no use for a liberally educated class, because generalization has been abandoned for specialization.
>
> Comfort becomes a goal when distinctions of rank are abolished and privileges destroyed.

The author's chief wrath falls especially on democracy:

> Equality is a disorganizing concept.
>
> No man was ever created free and no two men were ever created equal.
>
> Democracy does not recognize worth but demands conformity. Democracies if logical should choose rulers by lot.
>
> Programs like the four freedoms codify error.

Having now laid down his thesis and having indicted modern civilization, especially democracy, Mr. Weaver turns to remedies:

> Consciously, Man has three levels of thought: immediate needs; general beliefs; a metaphysical dream of the world.
>
> Logic depends upon dream; reason depends on faith.
>
> Some source of authority must be found; the only source is knowledge and knowledge means distinction and hierarchy.
>
> Every attack upon religion is an attack upon mind.

Coming to particulars, the author says:

> The right of private property is the last right remaining. Private property is the last domain of privacy. We must have small properties, independent farms.
>
> The state is not responsible for the poor or the criminal.
>
> Woman will regain her superiority when she finds privacy in the home.

One reads a book like this with a certain amazement and impatience. The author

tends to aphorism and brilliance of phrase; I have therefore quoted largely verbatim, but I still realize that phrases taken out of context may be misleading. Yet the main thesis is clear: Man has the power to control this world and has deliberately turned from truth to error and landed us in a mess. The less spectacular fact is that man assumes that his ideas and wishes have influence on the course of history, and human beings have usually worked on this assumption; but of course scientific proof of this assumption is impossible. Moreover, the bald statement that there is a source of truth higher than sensation, which man has deliberately ignored, simply goes beyond any known facts.

There was a time in this world when a single mind like that of Aristotle could comprehend most known knowledge; it is not the fault of the modern world, but rather its glory, that the vast accumulations of knowledge are such that no single mind dare assume it is master of them. The result, as Mr. Weaver reiterates, is unfortunate; this is no deliberate fault, but it is a situation to which we must give increasing thought. It will avail us nothing to toss away our hard-won knowledge and go off on a spree of unproven "Faith."

It is timely to rail at our assumptions of progress and power, but to regard the medieval gentleman or his successor, the Southern slaveholder, as better than the follower of modern democracy is nonsense. Our democracy is indeed pitiful in its accomplishment, but that is chiefly because we have not tried it, and not because human equality is not a defensible concept. The doctrine of equality does not deny authority nor hierarchy based on knowledge or moral character; but it does deny that the peasants of France belonged permanently in the gutter, just because some fool happened to be his father's son. Equality does not mean that slaves should rule Southern white men; but it does deny that a white man should own me body and soul just because he can spout Cicero.

When the author raves of the age of faith, the cathedral builders, and the complacent medieval doctors of philosophy, he forgets of what a small segment of the nation he is talking; he ignores the abject poverty, ignorance, and degradation of most Englishmen, Frenchmen, and Germans, and regards a handful of aristocrats as the whole nation. It is better that the majority of men should have food and shelter, even if they yet lack common sense. The doctrine of equality aims to release wasted ability, so that out of a far vaster sample of mankind than any previous age has used we may in time achieve leadership, reverence, and authority based on fact, and not on chance and exploitation.

W. E. B. DuBois
National Association for the Advancement of Colored People

LAND OF THE SHOGUNS

A Scientist with Perry in Japan. Allan B. Cole, Ed. xxvi + 307 pp. $4.00. Univ. of North Carolina Press. Chapel Hill. 1947.

Dr. James Morrow was "Agriculturalist" on the Perry Expedition to Japan in 1853. This book is, with only a modicum of editing, the journal kept by Dr. Morrow from the time he left Washington until shortly after he turned homeward from Java. The first twenty-three pages of the Journal are devoted to the trip to the Far East; pages 24–90 deal with stops at Hong Kong, Canton, and other places in China; and pages 91–112 report observations in Okinawa (called great Lew Chew by Dr. Morrow). Eighteen weeks spent in Japan, particularly in Tokyo Bay near Yokohama, at Shimoda, and in the harbor of Hakodate, Hokkaido, are reported in pages 113 to 205. Forty-seven pages are devoted to the appendices of the Journal, being primarily lists of seeds, plants, agricultural implements, and articles of commerce collected and distributed in China, Okinawa, and Japan. These appendices might well have remained unpublished and reference made to their existence among Dr. Morrow's papers.

The Journal is of some interest in reporting observations on customs of the people and the agricultural practices of the places visited. Readers who have seen this part of the Orient during the past few years will be impressed with how little change has occurred in almost a century since the Perry

Expedition. Throughout the Journal, references are made to the different crops observed in each locality. Unfortunately, however, these crops are often not sufficiently well named to permit accurate identification. Few scientific names are used, and common names are often vague. This is particularly disappointing in the frequent references to trips on which flowers were collected, without identifying any of the flowers found.

It seems unfortunate that the editor did not take more liberties in editing the Journal. In his day-by-day account, Dr. Morrow reported such prosaic tasks as pressing flowers that were collected or changing flowers put in press at an earlier date. These are necessary parts of a collecting trip, but they hardly add to the interest or value of the book.

This book seems to be worth while in placing in readily available form some additional facts about the Perry Expedition and some observations on Oriental culture, customs, and agriculture of that period. It is doubtful whether it will be of much interest to botanists, agriculturists, or general readers.

W. M. Myers

U. S. Regional Pasture Research Laboratory
State College, Pennsylvania

UP FROM SLAVERY

Liberia. Charles Morrow Wilson. 226 pp. $3.75. Wm. Sloane Associates. New York. 1947.

THIS volume was appropriately timed to appear in the centennial year of Liberia as an independent nation. In a perusal of the book one is reminded of the many unique features in the long history of this African republic. As early as 1773 Samuel Hopkins of Boston advocated the creation of a colony of freed slaves in Africa by recruitment from America. In 1781 President Jefferson strongly seconded the movement. The project had advanced far enough by 1822 for the establishment of a "commonwealth" under the guidance of Jehudi Ashmun, a sort of crusading prophet. Meanwhile, some 1,500 freed slaves, descendants of captives taken from West Africa, had made the journey under appalling hardships, in which more than half of them perished of tropical fever. These hardy pioneers laid the foundation of Monrovia, their capital, which they named after President Monroe.

The task that lay ahead of this little handful of ex-slaves was that of organizing an unsurveyed territory of tropical jungle, inhabited by twenty-three or more independent tribes of natives, into a workable Negro republic.

Finally, the little group of determined Negro founders, mostly from America, in July 1847 proclaimed the birth of the republic of Liberia, with a constitution fashioned somewhat after that of the United States, but with suffrage and land ownership limited to persons of African descent. It was promptly recognized by several European nations, but the slave interests of the United States prevented American recognition of Liberia until 1862. Meanwhile, France and Great Britain seized about 44 percent of Liberia's original territory and annexed it to their adjacent colonies of Sierra Leone, French Guinea, and Ivory Coast. At last in 1910 the United States committed herself to the moral support of the young nation.

As clearly shown by Mr. Wilson, Liberia has, almost without outside help, rounded out a century of history without serious internal dissensions; has brought about the federation of twenty-three native tribes; established roads, schools, hospitals, and other governmental institutions; and is now operating on a balanced budget with a national debt of only fifty cents per capita, an accomplishment the rest of the world might well envy.

Moreover, the unification of native tribes into a federated republic has not interfered with the very efficient traditional system of tribal control of local affairs. All such matters are handled by frequent community "palavers" in each village, palaver being the term applied to the strictly democratic town meetings throughout Liberia and elsewhere in Africa.

Even the vast development of the rubber industry by the Firestone Company, involving, as it does, more than half the cultivated

land of Liberia, as elaborately described by Mr. Wilson, has not unbalanced the economy of Liberia to the extent similar enterprises have done in other colonial countries. Employing 30,000 native laborers and producing 45,000,000 pounds of rubber yearly, this enterprise provides eleven of the twelve million dollars of exports annually.

Satisfactory progress is in evidence in educational opportunities, agricultural research, road building, and sanitation. The American Foundation for Tropical Medicine, with the cooperation of several American universities and the U. S. Public Health Service, has established The Liberia Institute for the study of the tropical diseases of man and animals. This is to be an international research center of outstanding importance.

Mr. Wilson has presented an excellent summation of Liberia's achievements on her hundredth birthday.

E. V. Wilcox

Washington, D. C.

RESTLESS SPIRIT

Maya Explorer. Victor Wolfgang von Hagen. xviii + 324 pp. Illus. $5.00. Univ. of Oklahoma Press. Norman. 1947.

IN THE 1840s a young New York lawyer, driven to the Guatemalan jungle by a restless and burning curiosity, discovered and unlocked a door that led deep into America's past. Now, a hundred years later, Victor von Hagen has drawn the first full-length portrait of this remarkable man in a biography that has authority and real narrative charm.

When John Lloyd Stephens finished the legal education supplied by his prosperous merchant father, he looked around—not for clients, but for somewhere to go. This was in a pattern that was to remain for all his forty-six years. The nation was young, and he tasted adventure first in a trip down the Ohio to the Mississippi. Then, his health weakened in the political campaign of 1834 (he was a Jacksonian Democrat and "a good talker"), he went abroad for a rest—and stayed two years. In Eastern Europe and the Holy Land he gathered impressions for two books, which later established him as "The American Traveller." In Egypt he acquired the passionate interest in ancient monuments that dominated his life. And in London he met a struggling artist and architect, Frederick Catherwood. Together they pored over the fanciful plates of Del Rio's *Ruins near Palenque.* Together they resolved to see for themselves, and from that compact grew the first and most fruitful collaboration in American archeology.

With bounding energy and imagination Stephens put his plan to work. Back home he talked about his travels with one of the Harper brothers, who suggested he "dish up something," whereupon he crammed his European experiences into two books that became best sellers. He got himself appointed by President Van Buren as special envoy to revolution-torn Central America. Then he sent for Catherwood, and they sailed south.

Stephens didn't find a government with which he could treat. But he did find a lost civilization in the jungles of Middle America. He rediscovered the cities of stone which the Mayas had erected centuries before Columbus—Copan, Palenque, Uxmal, Chichen Itza. With remarkable intuition he realized that these magnificent temples and pyramids fashioned by the ancestors of his impassive native guides were all related remnants of one great culture, a culture quite apart from the Old World and uniquely American. Through mud and jungle brush he drove on, with mosquitoes and malaria as constant companions, while Catherwood made the myriad meticulous drawings that are models even today. When Stephens published his *Incidents of Travel in Central America* in 1841, it was an instant and international success. But, more, it marked the beginning of the scientific study of the Maya.

The romantic quality of Stephens' life and the importance of his contribution are the two themes of von Hagen's book. Both are richly developed and blended against a background of the political and cultural currents of the period. Stephens has been, until now, almost completely neglected, and the author has done some very industrious picking of literary bones in order to present a rounded

picture of his central figure. Familiar personalities of the 1840s cross the pages—Prescott, of course, and Melville and Poe, Mme Calderon de la Barca and Philip Hone. The volume is richly and aptly illustrated with reproductions of Catherwood's on-the-scene drawings. A useful bibliography is included, and Maya glyphs as chapter headings add distinction to the handsome typographic design by Will Ransom, of Oklahoma. Victor von Hagen has written a useful and entertaining book. Any lover of the Maya (such as your reviewer) will warmly welcome it. Any others will find it an admirable romantic introduction.

BEN GRAUER
National Broadcasting Company
New York, New York

ONE MAN'S OPINION

Doctor Freud. Emil Ludwig. 317 pp. $3.00. Hellman, Williams. New York. 1947.

THIS sketch of the life, work, and influence of Sigmund Freud is in glaring violation of the ancient adage *de mortuis nil nisi bonum.* Alleging Freudianism to be of baneful effect upon human sanity and morals, the author launches here a one-man crusade of derision and vilification against the man who fathered psychoanalysis and is generally credited with revolutionizing psychiatric thought of our day.

Four indictments are straightway brought: that Freud erroneously confuses the motivation of abnormal behavior with that of normal behavior; that Freud explains "all neuroses as repressed sexuality"; that Freud endangers men and women by his teachings through the power of suggestion; that Freud has all art, culture, and religion originate in these same "suppressed desires."

In undocumented proof of these accusations an *argumentum ad ridiculum* is made out of fragments and inconsistent statements culled from the writings of Freud which bear on sex symbolism, dream interpretation, free association, sexuality of children, Oedipus complex, penis envy, transfer-therapy, etc. In addition, Freud is represented as having ceased to be scientific in order to become a seducer of all manner of men, particularly the fairer sex and sex-starved Americans, from the day he seized upon the notion of psychoanalysis. Considerable space is allotted to the perverted sexual motivations ascribed by Freud or members of his firm to well-known characters: Napoleon, Bismarck, Leonardo da Vinci, Goethe, Homer, Hamlet, and Moses. Special attention is drawn to psychoanalytic derivations of art, morality, and religion from *inter faeces et urinam.* Finally, the personal life of Freud is invaded, and the master psychoanalyst is himself analyzed as inordinately obsessed with craving for power and recognition, a stranger to nature, to music, to children, to play, to love-emotion, to the world outside his own, and ultimately to religious faith. About the only thing that the author sees to the credit of Freud is a "tremendous imagination."

This work by Ludwig falls far short of the merit of his other biographical studies. As a first effort at satire, it possesses commendable features. As a funny book, it brings down the house. As an erotic book, it is far more appealing than any tome of Freud. Hardly convincing is the sincerity of the author's protest à la Comstock.

F. C. SUMNER
Department of Psychology
Howard University

ASTRONOMICAL HISTORY

The Life and Times of Tycho Brahe. John Allyne Gade. xii + 209 pp. Illus. $3.50. Princeton Univ. Press for the American-Scandinavian Foundation. Princeton, N. J. 1947.

TYCHO BRAHE was to Danish science in the latter part of the sixteenth century what George E. Hale was to American science in the first part of the twentieth century. In several respects the similarity is remarkable. Both men had wealth, love of travel, extraordinary activity in varied interests, wide acquaintance, and vast correspondence. Although not reared in scientific families, both early acquired a fervent love of science; as boys, both had generous allowances, which they spent largely for scientific apparatus. Both promoted astronomy

by great skill and originality in devising instruments; and both were successful in obtaining from friendly sources funds for building the world's largest observatories.

Although genuinely devoted to science, Tycho unfortunately lacked the tact, modesty, and unselfish consideration for others that won for Hale continued cooperation and support. He was self-centered and neglectful of duty to an extent that alienated his patrons and partially wrecked his career. A scientist, like anyone else, can suffer from egotism and poor judgment.

In spite of his faults, which are frankly discussed in Mr. Gade's book, Tycho was a strong character and one of the world's greatest astronomers. He invented and constructed new and powerful measuring instruments; he assiduously accumulated vast stores of accurate data concerning the positions of stars and planets; and he made possible Kepler's analysis of the orbits of the planets, which in turn enabled Newton to find the general law under which they move.

The book will make good reading for those interested in astronomy, in the personal characteristics of a great man, or in the customs of the sixteenth century.

PAUL W. MERRILL
Mount Wilson Observatory
Pasadena, California

SO MANY A MILLION OF AGES

Men Out of Asia. Harold Sterling Gladwin. xviii + 390 pp. Illus. $4.00. Whittlesey House. New York. 1947.

SUPPOSE you claimed to be of the *Mayflower* lineage, and proudly hailed yourself "100 percent American" (good old Scotch-English-Irish ancestry!), and then some chap came along and said that the ship was filled with emigrants from Menangkaban, the Irrawaddy, Kamchatka, and a few fellow-travelers from the Kremlin for local color. Wouldn't you hang your genealogical head in chagrin? What price then your D.A.R. membership—you'd *never* get into Constitution Hall!

Well, Professor Gladwin does all this—and more—to the much pushed-around aborigines of North, Central, and South America. He soundly wallops several cherished and time-honored (not to say timeworn) ideas about the early Americans and their cultures: first, they aren't "100 percent Mongoloid," but are quite a polyglot bunch; second, their cultures were not conceived and delivered on this hemisphere, but instead were born in Asia, weaned crossing the Pacific and the Bering Strait, and were brought to adolescence over here; third, their civilizations, instead of being ancient, are relatively quite recent.

With a few crumbling skulls to go by, a broken pot here and a spear point there, a bit of historical evidence hither, and a most lively imagination thither and yon, Professor Gladwin weaves an intriguing pattern with the warp of space and the woof of time. (I promise you, you'll not stop reading once you start.)

Who *are* the American aborigines? Let the Professor tell you. It is possible that prior to 25,000 B.C. a few Negritos may have come in. But in 25,000 B.C. the treks began in earnest: (1) Australoid, 25,000—15,000 B.C.; (2) Negroid, 15,000—2,500 B.C.—the men of the Folsom culture; (3) Algonquin, 2,500—500 B.C.; (4) Eskimo, 500 B.C.; (5) Mongoloid, 300 B.C.; (6) Arawaks, 300 B.C.—A.D. 500. (That's really M.D., B.C.—Moving Day, B.C.)!

The Mongoloid migration, *ca.* 300 B.C., is Professor Gladwin's favorite. It was activated by the unrest in the Far, Middle, and Near East caused by the conquests of Alexander the Great. But he did more than start the migration: his followers, in the great "lost fleet," actually reached this hemisphere via a Pacific crossing, bringing fresh genes and a flock of cultural stimuli. As a result, aboriginal cultural traits in North America stem to China and Northwest Asia, while those in Central America and the Andean region stem to Polynesia, Melanesia, India, and the Near and Middle East.

Professor Gladwin is quite sure that some of his professional readers will be Doubting Toms. Such a one he labels P.D. (Phuddy Duddy). Please, Professor, I'm a P.H.D. (Pretty Honest Duddy). I like your book immensely. It is challenging and irritating (in the neurological sense of "stimulating").

Campbell Grant's line drawings will make the slick-paper "mags" look to their laurels. But really, I just can't see your Q.E.D. (Quite Easily Demonstrated). Instead, I must employ my own I.Q. (I Query!).

W. M. Krogman
Graduate School of Medicine
University of Pennsylvania

HETEROSIS

The Hybrid-Corn Makers. A. Richard Crabb. ix + 199 pp. $3.00. Rutgers Univ. Press. New Brunswick, N. J. 1947.

THIS is a readable book. It portrays the relative value of the early work of East and Shull in great detail and evaluates more accurately the importance of the work of East than other writers have done. Crabb rightly credits Jones with important discoveries. These discoveries include the double cross plan, which made hybrid corn feasible, and an up-to-date statement of a Mendelian explanation of hybrid vigor. Certain technical discoveries are overemphasized or overlooked. Two important errors of omission or commission are the inference that early testing is a desirable procedure with all breeding material, and the failure to emphasize prediction methods, which played so large a part in the rapid selection of desirable double crosses.

Some will believe the work of a few large seed companies, and of certain of their leaders, is overemphasized, even though all will agree that these companies played an imimportant part in developing hybrid corn. Others may wish that the work of hundreds of smaller seed producers and the organizations to which they belong had received more emphasis. And still others will doubt that sufficient credit has been given to the research work of the U.S.D.A. and state stations, for it is generally recognized that most early inbreds used by corn seed producers were selected by these research agencies. Without doubt the story would have been more accurate scientifically if the work of many who played an important role in the program had been described in a somewhat less laudatory manner.

The reviewer may be perhaps pardoned for a personal correction. Selection in self-pollinated lines was carried out seriously in Minnesota from 1915 on, although on a somewhat modest basis. Administrative leaders supported the work from the start, although it was not clear just how the inbreds obtained could be used to advantage.

Considering the difficulties, the wealth of available information from so many unpublished sources, and the fact that corn breeding is so highly technical, it seems probable that there will be conflicting viewpoints regarding this latest addition to the hybrid-corn story.

H. K. Hayes
Division of Agronomy and Plant Genetics
University of Minnesota

ILLUSTRIOUS PENNSYLVANIAN

Alexander Dallas Bache. Merle M. Odgers. vii + 233 pp. $2.75. Univ. of Pennsylvania Press. Philadelphia. 1947.

THIS biography of Alexander Dallas Bache, great-grandson of Benjamin Franklin, is one of a series of volumes covering the lives of noted Pennsylvanians. Bache's achievements as scientist, educator, and engineer, culminating in his service of some twenty-four years as the second superintendent of the U. S. Coast Survey, clearly warrant his place in this group.

The first chapter sketches the early period of Bache's life up to his appointment to the United States Military Academy at the age of fifteen. It contains various items of interest concerning his famous great-grandfather and other members of a large and, on the whole, exceptionally gifted family.

Bache's unusual attainments are brought out in the next three chapters, which treat of his graduation from West Point at the head of his class, his appointment and service as professor of natural philosophy and chemistry at the University of Pennsylvania (1828–36), and his election as president of Girard College on his thirtieth birthday, July 19, 1836.

Subsequent chapters cover a two-year trip abroad during which Bache collected material for a comprehensive report on European

educational institutions; his service as head of the newly organized Central High School of Philadelphia (1839–42); and his research and published papers on chemistry, terrestrial magnetism, and other subjects.

The last half of the book is devoted to his services to the nation in various capacities, but mainly as superintendent of the U. S. Coast Survey. His able administration of this bureau and his success in advancing its work are described.

The book is not only a biography of an outstanding American, but is also an account of the period in which he lived. It presents an interesting picture of the status of education in America in the early nineteenth century and of the trends in scientific thought at that time. The author uses many quotations and extracts from various sources. The gem of period letter writing appearing on page 14 is one of these that should not be overlooked.

A brief foreword by Rear Admiral L. O. Colbert, present Director of the U. S. Coast and Geodetic Survey, admirably summarizes the high lights of Bache's career.

J. H. Hawley

U. S. Coast and Geodetic Survey
Washington, D. C.

THE SOCIAL ORDER

Family and Civilization. Carle C. Zimmerman. 829 pp. $6.00. Harper. New York. 1947.

IN AN introduction the author states as the aim of this book—

> to discuss the family in its relation to civilization with four standards or ideals as to what constitutes a perfect sociological analysis. First comes *criticism.* Are the previous theories of the family valid? . . . Second, what has been the previous *history* of the civilized family. . . . Third, there is *thoughtful* analysis. Can the family be examined from the same analytical point of view applied to social problems by the great fathers of thought, Socrates, Plato and Aristotle? . . . Fourth is *causal* examination. Is the family a cause of development and change in civilization, or is civilization a cause of variation in the family? (pp. 16–17.)

The author has achieved the ends here set forth with varying degrees of success. For criticism, his chapters on Schools of Family Sociology and The Evolutionary Theory register comprehensive disagreement with the methods and conclusions of contemporary investigators. In thoughtful analysis he does maintain the analytic point of view of the great fathers of thought, Socrates *et al.*, with few concessions to modern methodology. In causal examination he fails to reach any very clear-cut conclusions. The most significant parts of the book are those dealing with history. Here the author has drawn upon an extraordinarily thorough and comprehensive knowledge of the source material for family studies as presented in early epics, classical authors, and the writings of early fathers of the Church. As a result he has been able to give an excellent picture of formal family institutions as they existed in the heroic period of the Indo-European-speaking peoples at various periods in Greece and Rome, and in Western Europe through the Dark Ages up to the present time. Although he makes a few slight gestures toward the Islamic, Indian, and Chinese cultures, he generally excludes these from his discussions.

Within the Western European frame of reference, he finds three types of family organization emerging again and again. These are the trustee, the domestic, and the atomistic families. The trustee family is based on the concept of the family as a self-perpetuating corporation with extensive functions relating to group property and the protection and control of family members. Such families are inevitably in conflict with emergent political authority. The domestic family develops out of the trustee family through increasing individuation of the primary family groupings within the trustee aggregate or "is revived by governmental or religious sanctions from the atomistic type" (p. 130). The atomistic type is one in which the individual is as far as possible freed from family bonds and the state is regarded as an organization of individuals rather than family units.

The author finds significant parallels between our own recent history and the Greek and Roman developments, with their progression from trustee through domestic to atomistic families, with resultant collapse. He even finds the primitive trustee type of

family still surviving among our Southern mountaineers, and the descriptions of these units is one of the most interesting sections of the book. Unfortunately, he has no concrete suggestions to offer on how the current degeneration of the family is to be halted.

RALPH LINTON
Institute of Human Relations
Yale University

WHERE THE HIGH WINDS BLOW

Cache Lake Country. John J. Rowlands. 272 pp. Illus. $3.50. Norton. New York. 1947.

ALTHOUGH the subtitle of *Cache Lake Country* is "Life in the North Woods," this fascinating book could with all propriety be called "How to Live in the North Woods." John J. Rowlands tells us little of himself, but a great deal of how and why he lives in the cold-water country.

Author Rowlands' cabin looks over Cache Lake, "protected by distance, mile after forgotten mile of woods and water, and it is still clean and clear and safe from civilization." More than thirty miles from the nearest settlement, his human neighbors are Henry B. Kane and Chief Tibeash, a Cree Indian. That these three men, whose cabins are a couple of miles apart, find extraordinary satisfaction in their environment is evident in every page of the book.

Cache Lake Country is in fact a manual for self-sufficient living, for it contains directions for obtaining shelter, living off the country, transportation, first aid, cooking, recipes, sled-dog training, all neatly indexed for ready reference. The book reads as interestingly as a series of letters from your brother.

Mr. Rowlands is a modern backwoodsman. He writes of balsam-bough beds, birchbark canoes, and snowshoes, but he also talks of mattresses, DDT bombs, and airplanes. Instructions on how to lift a pack or how to keep warm are balanced with writing like this: "When May comes to the north country it reminds me of a fawn walking out of the woods alone for the first time, wide-eyed and uncertain about what to do next."

Hank Kane's illustrations complement the text on nearly every page. These drawings often picture a practical point made by Rowlands and are always decorative. This is a handsome book of real use even to people who do not venture much beyond their own back yards.

Here are a former timber cruiser who tells how to avoid forest fires, an artist who hunts with a camera, an Indian who "made a speech to the bear, explaining that he would not take his life if he did not need his fur for warmth and the grease for his people." You will like these men.

ROBERT D. MCMILLEN
Farm Journal
Washington, D. C.

MATHEMATICS—AND BEYOND

One Two Three . . . Infinity. George Gamow. xi + 340 pp. Illus. $4.75. Viking. New York. 1947.

AMONG the so-called popular books on science, there are very few that will appear exciting to the scientist and both exciting and comprehensible to the layman. To say that Gamow's book has just this quality means to bestow on it the highest possible praise. Indeed, it deserves it.

One often finds that a reviewer regards Jeans' popular writings as the highest level of popularization, and that he judges other writings by their distance from Jeans' masterpieces. It is high time to debunk this legend. Let me say (and here I mean it as a compliment) that Gamow is very much unlike Jeans. Gamow does not mix science with metaphysics or theology; he does not frighten the reader because the stars are far and lonely and because the atoms are small. He neither produces metaphysical thrills nor talks as a high priest of learning; he does not analyze the mathematical abilities of the creator of the universe. All that Gamow does is to tell a fascinating story with grace, clarity, and wit.

The book starts with Mathematics; then follow chapters on Relativity, Atomic Physics, Biology, Astronomy.

Thus, it is a tale "of many things; of atoms, stars and nebulae, of entropy and genes."

Yet I am neither surprised nor impressed by the knowledge that the author shows. Knowledge can be easily enough collected from books. But I am impressed by the author's good taste in collecting the proper things, in putting them in the right perspective, so that they form an exciting and dramatic story, made even more so by the artistic simplicity of presentation.

If you read Gamow's book, you will find in it something much more than knowledge. You will find an understanding of the spirit of modern science; the realization of its achievements and failures; the great progress gained through blunderings and retreats (as in the theories about our solar system, for example). All this is done in a pleasant, unpretentious way with excellent humor, which only rarely seems slightly strained.

During my lifetime, I have read hundreds of popular books on subjects overlapping those in Gamow's book. Many of them seemed to me like rewritings of the same book. Yet I could not lay down Gamow's book until I read it through. I also liked very much the author's delightful drawings. Let us hope that the book will sell as well as Jeans' *Mysterious Universe,* of which it did not remind me.

LEOPOLD INFELD
Department of Mathematics
University of Toronto

MAN VERSUS INSECT

Insects and Human Welfare. Charles T. Brues. xiii + 154 pp. $2.50. Harvard Univ. Press. Cambridge, Mass. 1947.

THE reappearance of this 1920 book in a well-modernized revision makes available to the general reader a very thoughtful summary of the present stage in the battle between one species—man—and 800,000 other species—the insects. The struggle is analyzed on four fronts: Insects and the Public Health, Insects and the Food Supply, Forest Insects, and Household Insects.

In the fifty years since insects were first suspected of carrying human diseases, no period has given such a sweeping opportunity for their spread as the recent war, when men and materials were shipped from hemisphere to hemisphere, from temperate civilizations to tropical jungles. Yet in reviewing the malarial fevers, yellow fever, filariasis, and others, Professor Brues is decidedly optimistic. He looks forward to no serious outbreak, but to a better understanding of diseases now known to be transmitted by insects and to new revelations that will make possible control of still other human ills.

The food front is not doing so well. The annual twenty-million-dollar loss in crops and stored harvests in the U.S.A. alone is a measure of the failure of even the best insecticides to cope with the problem, and an indication of the importance of long-range biological control through propagation of insect diseases and parasites, protection of predators, and of improved crop management practice to prevent development of epidemics.

Forest insects have an even freer hand, partly because infestations are harder to handle, partly because trees grow slowly and any money for protective measures is begrudged owing to a "deep-seated human aversion for rewards in the too-distant future." The sequence with which insects and fungus diseases attack and destroy trees is emphasized for the New England elms, where several European pests cooperate like workers on an assembly line.

Professor Brues compares man's homes and cities to an ant or termite nest, and shows how the various household insects fit into their niches. Some of them have troubles too. The fruit flies that hover around ripe fruit are alcohol lovers that may drown in an open flask of Kentucky corn whisky, "never having had experience with the more powerful condiments to which we ourselves have grown immune." House spiders and various wasps that annoy us turn out actually to be friends. He even points out a kinship between the pestiferous clothes moths and some whose larvae "feed on the fur of living animals, such as sloths, and about the base of horns of certain African ungulates." Perhaps the first fur coat presented by a cave man to his wife had moths in it from the very start! And the "bookworms," which include termites, the larvae of certain beetles,

cockroaches, silverfish, and others, probably prefer "antique volumes or first editions . . . due to previous invasion by molds which enhance their food value." *Insects and Human Welfare* is interesting, informative, and thought-provoking without being technical. An index adds to the usability of the new edition.

LORUS J. and MARGERY J. MILNE
University of Vermont

SCIENCE AND SOCIETY

What Is Life? J. B. S. Haldane. x + 241 pp. $3.00. Boni & Gaer. New York. 1947.

Education for What Is Real. Earl C. Kelley. xiv + 114 pp. $2.00. Harper. New York. 1947.

THIS outstanding British biologist has stepped down from the Ivory Tower and presented for the lay reader, factually and clearly, what is actually known as to the complex life processes of man and other animals in health and in disease. Some of the sections of this volume had prior publication in the London and the New York *Daily Worker,* the World Union of Freethinkers, and in the Penguin Series. The four sections of the book have the following headings: Is Man a Machine? Heredity and Environment; Science and Society; Science for Society. The author is convinced that "people can and should think scientifically about themselves" (Preface). To do that we have to present our children with better education in human biology than that available, even in Great Britain and America, in the past fifty years. This book tries to remedy that deficiency through education of the adult generation of 1948. A careful study of it will aid in that direction. This reviewer is puzzled by one sentence in the Preface. Dr. Haldane tells us that "Science made him adopt Marxism as a working hypothesis about how men behave and how changes in nature and society occur." Science, yes, *real science,* antedates Karl Marx, and I find nothing of the Marxian political philosophy, or practice, in the author's presentation of the known facts in this book, unless such a meaning may be conveyed in this paragraph (Preface): "I want Americans to be healthy and happy not only because they are human beings but because the happier they are the less likely they will be to interfere with other peoples as we British have done in the past, with disastrous effects." In my opinion, science alone, philosophy alone (including Marxism), religion alone, has not yet made all men honest, sane, humane, and just. Period.

Few informed citizens will object to the title of Kelley's book: *Education should deal with the known, the real in man and nature.* But, in the judgment of this reviewer, the author deviates now and then from this fundamental theme. Vision, though important, is just one of our senses through which we perceive, learn, and understand. Nature does not always play the tricks with our visual sense perpetrated by the experimenters at the Hanover Institute. Some will put a question mark after the statement, "Individual purpose is basic to perception" (p. 103). As to average normal persons, there are at least as many and as important identities and similarities in body machinery, functions, and experience as there are unique differences. We do have "a common world," and "nature does repeat." We are told (p. 68) "when we make children learn that for which they see no need, it is doubtful if learning goes on at all." If the author means that a real teacher can or should make the child see the "need," I agree. But, as I understand man and other animals, conditioning and other forms of learning (and understanding) cannot be delayed or made entirely dependent on the infant or the young child understanding his personal and social needs in future years.

A. J. CARLSON
Department of Physiology
The University of Chicago

HISTORICAL MEDLEY

400 Years of a Doctor's Life. George Rosen and Beate Caspari-Rosen. xvii + 429 pp. $5.00. Schuman. New York. 1947.

THIS book attempts to present, through autobiographic excerpts from more than eighty doctors, a composite picture of the medical man. The excerpts are arranged to

represent a life-history sequence, with the following major headings (the number of excerpts for each section is given in parentheses): Early Years (11), School Days (8), The Medical Student (31), The Practice of Medicine (28), Scientist, Scholar, Teacher (22), The Doctor Marries (19), The Doctor as Patient (12), The Doctor Goes to War (15), Writing and Politics (6), and Reflections on Life and Death (9).

Most of the selections are introduced with a brief biographical characterization of the man, and since nearly every well-known doctor (and some not so well-known) from the sixteenth century on is represented, the total provides quite a potpourri of medical history —or better, a historical lagniappe.

The book should provide the established doctor with much pleasant browsing, the eager medical student with inspiration, and the patient—each of us at one time or another —with a frankly humanizing portrait of the man who often plays God.

George F. J. Lehner
Department of Psychology
University of California
Los Angeles

FIGHTER FOR AMERICA'S FORESTS

Breaking New Ground. Gifford Pinchot. xvii + 522 pp. $5.00. Harcourt, Brace. New York. 1947.

Gifford Pinchot died on October 4, 1946, leaving the manuscript of this book. It is an important book because it treats authoritatively a subject of vital concern to every citizen—conservation of natural resources; no one else could have written it. Pinchot was the first professional forester in America, the organizer and first chief of the Forest Service, and coauthor with Theodore Roosevelt of the Conservation Movement in this country. His book, autobiographical in approach, is the story of Pinchot's career from 1889 to 1912—an eyewitness account of how practical forestry and conservation came to America.

Even as an octogenarian Pinchot is true to form and pulls no punches. His account of the struggle to get the control of the forest reserves transferred from the Department of the Interior to the Forest Service, of the famous Pinchot-Ballinger-Taft Controversy (which cost Pinchot his government job), and of the enemies of the Rooseveltian conservation policies is told fairly and squarely. It is rich in reminiscence, articulately appreciative of colleagues, critical but unvituperative. Although as a literary masterpiece the book leaves much to be desired and would have profited by further editing, it is nevertheless impellingly readable because of the vital nature of its message; for there is little doubt that the Conservation Movement, which Roosevelt and Pinchot sold to the country, was the most important public awakening in our history—and the fight is still going on. Pinchot's ideas on the subject of conservation as a basis for permanent peace were a projection of his conservation thinking, and it may be that we have not yet heard the last of them.

I am sorry that Gifford Pinchot did not live to complete his memoirs, to give us the story of the last thirty-five years of his colorful life. (After he was sixty he was twice governor of Pennsylvania.) But we must be thankful that he finished the most important segment, representing the part that must have given him the greatest satisfaction. He was a great personality and a great American; his book deserves a wide reading.

Paul H. Oehser
Smithsonian Institution
Washington, D. C.

SCIENCE ON THE MARCH

THE NUCLEAR CYCLE IN THE FUNGI

WITHIN the past two decades there has been a noticeable increase in the study of nuclear cytology and nuclear behavior in the fungi. This is due to a number of factors, including the recent discoveries of important fungus-produced antibiotics such as penicillin; the increasing importance of fermentation products of various fungi, particularly the yeasts; the ease with which the majority of fungi may be cultured and made to complete their life histories in a few days on simple agar media; and the unusual nuclear cycle through which they pass. This discussion is concerned primarily with the last-mentioned factor.

In most species of fungi, almost the entire life cycle is characterized by the presence of haploid nuclei in the plant body, whereas the diploid nuclei are restricted to one short phase —in fact, to one type of cell, the zygote—produced during the latter part of the life cycle. Obviously, this is in contrast to the condition in higher plants, where the diploid phase is more elaborately developed and the haploid phase is confined to the much-reduced gametophytes. Herein lies one of the unique advantages of the fungi in genetical work. They offer an unexcelled opportunity for the study of haploid nuclei and their effect upon the development of the organism. In essence it is possible in fungi to study the effects of one set of chromosomes upon the organism, instead of the two sets that are inevitably present in the diploid cells of the higher plant body. This is applicable also to the gametophytes of algae, mosses, and ferns; but these are generally more difficult to culture in the laboratory and have therefore not attained the popularity of fungi in genetical work.

The cytologist and geneticist have turned most of their attention to the study of the higher fungi (Ascomycetes and Basidiomycetes) rather than the lower fungi (Phycomycetes). This preference exists primarily because it is seldom possible, in the latter group, to analyze all the products of a single meiotic division, and the nuclei are generally too small to allow accurate observations of chromosomal behavior during nuclear division. In the higher fungi, however, the nuclei are frequently of a size that will allow more accurate cytological observation. This is particularly true of the diploid fusion nuclei, which in some species may attain the size of an average higher plant nucleus. Even more important to the geneticist is the fact that, in these higher fungi, all the products of a single meiosis may generally be recovered.

In Ascomycetes, nuclear fusion occurs in the young ascus (zygote) and is followed ordinarily by three successive divisions of the diploid nucleus, of which the first two divisions are reductional and segregational. Eight haploid nuclei are produced. By the process of free cell formation in the ascus, the 8 nuclei are enclosed in 8 separate cells—the ascospores. By analysis of the mycelia obtained from germination of these spores it is possible to obtain a considerable amount of information on what happened during meiosis, particularly with regard to segregation of such factors as those that influence sex, rate of growth, pigmentation, and substances produced in the medium. Factors controlling parasitism are also receiving increasing consideration.

In Basidiomycetes, nuclear fusion typically occurs in the young basidium (zygote) and meiosis follows. Here there are characteristically two divisions of the diploid nucleus, resulting in the production of 4 haploid nuclei, which pass separately into 4 different spores —the basidiospores—produced externally on the basidium. These 4 spores, containing the products of meiosis, may be analyzed in the same manner as the ascospores mentioned above.

In certain species of pink bread molds (*Neurospora*), in which 8 ascospores occur in a single series within the ascus, and in rusts and smuts with septate basidia, it is frequently possible to recover and analyze the products of meiosis in the exact order in which they were produced. In these cases it is possible for the investigator to determine where reduction and segregation occur and to obtain much valuable information on the crossing over of chromosomes.

When an ascospore or basidiospore germinates, it ordinarily produces a mycelium whose cells contain one to several nuclei, all of which are haploid and genetically alike. In many species, if the life cycle is to be completed, it is necessary for two compatible mycelia—that is, mycelia whose nuclei have a mutual attraction for each other—to be brought together before the life history can be completed. Such fungi have been termed *heterothallic*. At some point in their development there is an association of the two types of nuclei. This is often brought about through hyphal fusions or by a copulation of sex organs. Eventually, a different kind of hyphal growth appears, in which the compatible nuclei become associated in pairs, usually one pair in each cell. During cell division the two nuclei divide simultaneously in such a way that each new cell will contain a pair similar to the first. Such nuclei are known as *conjugate* nuclei, each pair also being frequently referred to as a *dikaryon*. They represent two genetically different sets of chromosomes in two separate but closely associated haploid nuclei. Eventually these dikaryotic hyphae give rise to asci or basidia in which the pairs of nuclei fuse to produce the diploid nuclei. This is followed by meiosis, as has already been pointed out.

Other species of fungi, termed *homothallic*, normally complete their life history when grown from a single haploid spore. Such a single-spore mycelium may give rise to dikaryotic hyphae as in heterothallic forms, and in the majority of species investigated there is a nuclear fusion. This has generally been considered an association and fusion of two genetically similar nuclei. The possible advantages of such a nuclear cycle are not so apparent. A similar condition exists among certain of the algae, mosses, and ferns.

In recent years it has been found that a number of fungi, ordinarily considered homothallic, may produce certain distinct strains which, when mated, will cross with one another. The parental types can be recovered after meiosis, proving that both parent strains contributed to the production of the fusion nuclei. Although the significance of this behavior is not fully understood, the recognition of it requires that we revise further our old concepts of homothallism and heterothallism.

In higher plants there is no phase equivalent to the dikaryophytic phase in the higher fungi. In mosses, ferns, and seed plants a similar condition would prevail if, at fertilization, the egg and sperm nuclei failed to fuse, but remained closely associated and underwent simultaneous divisions so that each cell of the sporophyte would contain two haploid nuclei. There has recently been considerable debate over whether the dikaryotic cells in fungi can be considered diploid. There are convincing arguments pro and con. Obviously, in the higher fungi only the ascus and the basidium are the exact equivalent of a diploid cell in higher plants. They are the only cells containing two sets of homologous chromosomes in the same nucleus. True dominance and recessiveness may be expressed here with respect to the factors controlling the development of the asci and basidia.

One of the chief questions raised lately is whether true dominance can be expressed in the dikaryotic phase and whether a dikaryon may have the same influence upon a cell as would a single diploid nucleus containing the same two sets of chromosomes. The evidence pertaining to this question is scanty, but one applicable case may be mentioned.

In wheat rust the uredospores contain a pair of haploid nuclei representing a dikaryon. The teliospore cells at first contain dikaryons, but there is an early nuclear fusion, so that each cell contains a single diploid nucleus. It has been shown that the color of the spore walls is controlled at a single locus on a

chromosome. A dominant and a recessive gene have been found at this locus. It has been further demonstrated, through hybridization experiments, that when one or both of the dominant genes are present in either spore the wall is distinctly colored. Likewise, when two recessive genes are present in either spore, the wall is pale. Thus it appears that, at least in some cases, two homologous sets of chromosomes located in two different haploid nuclei in a cell may have the same influence upon certain characters as when the two sets of chromosomes are combined into a single diploid nucleus.

The above discussion has emphasized the fact that fungi in general are characterized by the presence of haploid nuclei throughout most of their life cycle. There are several noteworthy exceptions. There is some reason to believe that certain Phycomycetes may produce in a single life cycle both haploid and diploid thalli, but this is in need of confirmation. However, it has been genetically (and possibly cytologically) proved that in some yeasts, including brewers' and bakers' yeasts, the vegetative phase is normally diploid, each cell containing a diploid nucleus. It has been possible to establish true hybrids among these yeasts, some of which are superior to the parent types in their fermentative abilities. As would be expected, true dominance and recessiveness are expressed here as in higher plants.

The more critical cytological and genetical studies have shown that the nuclei of fungi behave essentially like those of higher plants during division. In both somatic mitosis and in meiosis, spindles develop and the chromosomes arrange themselves upon them, subsequently splitting apart and passing to the poles, as in higher plants and in most animals. In the fusion nucleus, synapsis of chromosomes occurs, followed by the other characteristic meiotic prophase stages found in higher organisms. Reduction in chromosome number is now believed to occur generally during the first division of the fusion nucleus, as is characteristic of higher organisms. Segregation may occur in both the first and second divisions. Chiasmata have been detected cytologically in some cases and crossovers have been proved genetically in a considerable number of fungi. In the pink bread mold, *Neurospora crassa,* the sex chromosome has been mapped out, with a number of loci plotted upon it. Evidence of gene mutation has been recorded for a number of fungi.

In view of the above considerations, it is obvious that the fungi have obtained a well-deserved recognition in providing a rich field for cytological and genetical investigation, the results of which have already contributed, and will continue to contribute, much to our knowledge of the structure and behavior of nuclei in general.

LINDSAY S. OLIVE
Department of Botany, Bacteriology, and Plant Pathology
Louisiana State University

ITINERARY*

FIRST ANNUAL INTERNATIONAL PHOTOGRAPHY-IN-SCIENCE SALON

BROWN UNIVERSITY and PROVIDENCE ENGINEERING SOCIETY, Providence, Rhode Island	April 22–May 6
GAMMA SIGMA EPSILON, University of Florida, Gainesville	May 13–June 1
THE JOHN CRERAR LIBRARY, Chicago, Illinois	June 8–June 21
AUBURN CAMERA CLUB, Bureau of Animal Industry, U.S.D.A., Auburn, Alabama	June 28–July 12
AMERICAN OSTEOPATHIC ASSOCIATION ANNUAL CONVENTION, Boston, Massachusetts	July 19–23
ACADEMY OF SCIENCE, Illinois Wesleyan University, Bloomington	Otober 1–15

* Dates available for showing both 1947 and 1948 Salon pictures.

COMMENTS AND CRITICISMS

LAST WORD ON GARRETT

Mr. Garrett's article in your October 1947 issue has just been brought to my attention. The article implies that even after environmental influences have been equalized as much as possible, the intelligence of the Negro is still considerably lower than that of the white.

If the above be granted, however, one is forced to a conclusion of doubtful validity. There are many hereditary factors, such as shape of head, eye color, size of head, color blindness, and the like. No correlation has been found between any of these and intelligence. The only hereditary factor purported to show any correlation with intelligence is skin color. This would force the conclusion that the genes for intelligence and the genes for skin color are in some way linked, since otherwise there would be no reason for the alleged relationship. Inbreeding among people of the same skin color will not serve as an explanation unless it can be shown that mulattoes have a higher intelligence than Negroes; i.e., the mulattoes living in a Negro community must be compared with their neighbors in the same economic group. No such differences have been found to exist. By this *reductio ad absurdum* we are therefore thrown back to the hypothesis that intelligence differentials of this sort must be explained in terms of environmental factors.

HERBERT CAHN

New York, New York

ONE MAN'S MEAT . . .

"Crumbling Rocks," by Janssen (SM, August 1947), has drawn forth more or less disparaging remarks from a couple of correspondents (SM, January 1948). I cannot resist the temptation to add a few remarks, not for the purpose of praising or of criticizing the content of Dr. Janssen's article, but to bring out what I believe to be a fact, namely, that too few of us possess enough tolerance toward the ideas of others on questions of publication policy. A. O. Kelly apparently would proscribe the publication in SM of any article made up largely of old stuff not comprising a step in the advancement of science. During the past 10–15 years I can remember reading in SM what for me were very enlightening articles on such subjects as the development of microscopy, of astronomy, of cosmological theory, and the theory of isostasy. In the journal of February 1948, Professor Hobbs contributed an article on "American and Eurasian Glaciers of the Past." Some of the ideas in this article date back to Hobbs' *Earth Features and Their Meaning*, published 36 years ago, and might therefore be called "old stuff" and "hardly a step in the advancement of science." However, the article in question tells of much growth in the comprehension of glacial theory during the past 30–40 years by filling in several vacuous spaces in the fund of information formerly at the command of the casual observer.

It is probably true that portions of many SM articles are old stuff to the specialist. Nevertheless, some readers will consider these to be contributions to the advancement of science, since they help to furnish an enlightening background for more general comprehension of trends in scientific investigation. If only articles equivalent to a Ph.D. dissertation were to be published in SM, the journal's appeal to the nonspecialist member would depreciate greatly, and, in consequence, the over-all contribution to the advancement of science would be slight. In the long run, scientific advance is related to the general philosophical attainments of humanity.

As a member of the Association, occupying a humble position in technology, I crave to be somewhat acquainted with the thoughts and ideals of those greater scientists who are shaping our conceptions of the universe in which we live. Let us remember that new generations of scientifically interested people are continually emerging, and that they, even as specialists, wish to know something about the historical aspects of other fields than their own. Therefore SM, as a journal of enlightenment, must continue to serve up a considerable amount of rehashed material.

C. A. LYFORD

East Aurora, New York

CLOTHO, LACHESIS, AND ATROPOS

Professor Leslie A. White's article on "Man's Control over Civilization: An Anthropocentric Illusion" (SM, March 1948) presents a thoroughly deterministic viewpoint. Admittedly having no free will, Professor White could have done no other than write precisely the article that he did. However, my own background being somewhat different, I find myself moving toward an argumentative response.

First, let us examine the consequences of belief or disbelief in free will in a deterministic world—not that we can do anything about it, but simply to see whether this isn't a case where the folly is in being wise. We may take as a starting point Professor White's article, which will have exerted an influence on all who have read it. We may suppose that some persons, who never previously questioned the freedom of the will, will have been started on a new line of thought leading eventually to complete acceptance of determinism. Others, not wishing to acknowledge that they have been in error, will have reacted in opposition. They will engage even more actively than before in exhortations to their fellow-men to make the world better. Where will all this lead?

Of course, a deterministic world can change only to the extent to which it was bound to change anyway. Professor White was already a part of the system. He was bound to write his article, and it was bound to set in play the kinds of forces that will be described here. What is being considered is simply how the results will be different from what they would have been had some *deus ex machina* been able to intervene and snatch the pen from the professor's hand.

Obviously, the people who have been influenced to become complete determinists will hereafter be more inclined toward snap judgments and ill-considered actions; for, inasmuch as directed thinking is hard work, the determinists, after having turned over one or two possibilities in their minds, will suddenly and thankfully recollect that what will be, will be. They will then cease to pommel their brains. They will also shirk disagreeable physical activities more than ever before. As soon as a man finds that he can drop his hoe and lie in the shade he will do so, knowing that he could do no other. Except in cases of considerable need, there will be little striving against adversity on the part of these thoroughgoing determinists. Their philosophy will give them no stomach for it. They should not be blamed, for they actually have no free will. Nevertheless, their last state will be worse than their first.

But what of the people who react in opposition and set out to prove the author wrong? I have high hopes for some of those who found themselves called "educators" (complete with quotation marks). By way of protest they will work more actively than before for a better world. It will be purely a matter of stimulus and response—but what a response!

The now more ardent educators will work still harder and achieve greater influence. If they are really great educators with great messages they *will* succeed as never before in improving their civilization. What matters it if they preach free will when there is none? If they convince their hearers, these too will see no inconsistency in striving for a better world. Only through such endeavor will civilization actually improve, even in a deterministic world. The small results from some of the efforts at improvement which Professor White mentions are not evidence against the possibility of more marked improvements when the leavening agents are more powerful.

It seems to me, then, that to the extent to which people disbelieve in free will, the effect will be undesirable, and to the extent to which they believe, the effect will be good. The argument does not presuppose that there *is* free will. It assumes the opposite and examines simply the effect of a belief or disbelief in free will in a world in which there is actually none. It may be deduced, however, that the effects will be similar if there is actually freedom of will. The essence of the matter is that "faith inspires to effort, while doubt freezes the soul and paralyzes the arm. Men who do not believe do not achieve." Willard C. Selleck, who used these words in another connection, prefixed the word "intelligent." However, even though it may not be intelligent to believe in free will, the effect will still be good. If this be scientific heresy, let us make the most of it. We'd better!

I intend no disrespect to Professor White. He occupies what many regard as a very strong logical position. However, the complete denial of free will is one philosophical doctrine that does not seem to wear well in the world of practical affairs. Professor White has had the fortitude to venture out there with it, and he appears to have handled it consistently—a difficult task. Consistent application of out-and-out determinism in the world of man is deserving of some admiration, purely as a mental accomplishment. Sir James Jeans, who in spite of Professor White's quotation, admitted the force of the arguments against free will, wrote of the "characteristic irrationality" of the thoroughgoing determinist. Also, Esmé Wingfield-Stratford said that "if you turn out free will by the front door, there is nothing for it but to leave the back door quietly ajar, and let mum be the word."

It will have become evident that I believe that our wills do have some measure of freedom. Neither the argument from science nor the argument from pure logic seems to me to be profound enough to rule this out. I am encouraged by knowing that there are some eminent and highly accomplished scientists of like mind. But even in cases where close reasoning does seem to leave no loophole, it is well to remember that there have been logical paradoxes before now, some of which have been resolved in favor of the common-sense view. Zeno seemed to have an airtight case against the possibility of Achilles getting past the tortoise. I confess that the argument still fascinates me with its apparent conclusiveness. Nevertheless, it is evident, now, that Zeno got into a blind alley by adopting an approach that did not permit him to apply his reflections to a sufficient length of time. We have Bertrand Russell's word for it that the paradox is now completely resolved, with the race going to the swift, barring the contingencies of Ecclesiastes 9:11.

In subscribing to the freedom of the will, I place considerable confidence in what might be called "the argument from the existence of consciousness." Consciousness is a unique and most extraordinary manifestation, the very existence of which constitutes a striking anomaly in any deterministic world. As Arthur Compton says, "We find that among the higher animals the course of evolution has brought consciousness to an ever higher level of development. Why should this occur if consciousness were of no value to the life of the animal, and how could it be of value to the animal if it were incapable of affecting its course of action?"

HAROLD H. STEINOUR

Evanston, Illinois

TECHNOLOGICAL NOTES

Men and fish. Something about an island is cozy and snug. You know exactly what the limits of territory are, without choosing arbitrary boundaries. That definiteness of subject appears in a 140-page study called *South Bass Island and Islanders,* by Thomas Huxley Langlois and Marina Holmes Langlois. He is director of the Franz Theodore Stone Laboratory, of The Ohio State University, at Put-In-Bay, on South Bass Island in Lake Erie. She is Mrs. Langlois.

Dr. Langlois is a limnologist, and his professional interest is reflected in the approach to the social and economic relationships of the 273 human beings on the island. The Foreword is mostly quotation from a bulletin on the lives and habits of a colony of bass in a rearing pond where "The most desirable crop consists of the maximum number of individuals with the maximum mass weight." The parallel isn't exact; the way to prevent cannibalism in the fish is to provide plenty of food, and presumably lean years in the island economy would not lead the islanders to prey on each other.

Indeed, as the study shows, members of the human colony work together. This symbiosis produces a far higher return than the sum of individual efforts, no matter how energetic. The workings of the division of labor show up sharply in the various industries—real estate, wine, fishing, innkeeping, and transportation—and the union for protection is evident in the group decisions about education and religion, in the arrangements for sanitation and health, and in the organization for fire protection. For example, getting and keeping a doctor required community action when such behavior was unusual; since about 1880 the islanders have furnished an office-home for the physician. The post has its hardships; three of the sixteen doctors who have practiced on the island have drowned in Lake Erie.

South Bass Island was settled in 1811. Since then the industries have developed and fluctuated. Cutting and shipping ice had a boom at the time of the great ice famine in the early nineties, and then disappeared. Vineyards require the growing of a certain amount of rye, to tie up the vines. Fishing is not what it used to be, and hotel keeping, which flourished early in the present century, has now become largely a matter of catering to short-time visitors and furnishing an occasional meal to the summer residents, many of whom own their own cottages and have become part-time permanent islanders.

Sugared marble. We have all seen marble walls become dull and dark, a grievous disappointment in public monuments and buildings, but probably we have supposed that only the surface is spoiled. A study at the National Bureau of Standards indicates that the situation may be more serious. Weathering is not simply the effect of rain and acid fumes, freezing and thawing. When the dense tangle of calcite crystals—perhaps less than 1 percent voids—in a typical marble is heated, the crystals expand along one axis and contract in the other dimensions. On cooling the movement is reversed. The crystals cannot always return to their original positions, and the block tends to swell or grow. As much as 3.5 percent expansion has been observed. The solid block becomes a porous mass of sand. Marbles vary in their sugaring tendencies. When this property has been fully catalogued architects will have guidance for the selection of the right stone.

Hunger for copper. Battelle Memorial Institute, founded in 1929 at Columbus, Ohio, for cooperative research on metals and fuels, affords many examples of the ramifications of subjects and interests. Metals affect vegetation, so Battelle is engaged in agricultural research. A recent report from the Institute tells of the need for copper as one of the "micronutrients" in growing plants. Fertilizers enriched with copper sulfate improve soybeans, cotton, potatoes, and other vegetables noticeably, though the benefits haven't been definitely measured. Tobacco, in particular, responds to a copper ration by improvement up to 30 percent or more in quantity and quality.—M.W.

Of course, a deterministic world can change only to the extent to which it was bound to change anyway. Professor White was already a part of the system. He was bound to write his article, and it was bound to set in play the kinds of forces that will be described here. What is being considered is simply how the results will be different from what they would have been had some *deus ex machina* been able to intervene and snatch the pen from the professor's hand.

Obviously, the people who have been influenced to become complete determinists will hereafter be more inclined toward snap judgments and ill-considered actions; for, inasmuch as directed thinking is hard work, the determinists, after having turned over one or two possibilities in their minds, will suddenly and thankfully recollect that what will be, will be. They will then cease to pommel their brains. They will also shirk disagreeable physical activities more than ever before. As soon as a man finds that he can drop his hoe and lie in the shade he will do so, knowing that he could do no other. Except in cases of considerable need, there will be little striving against adversity on the part of these thoroughgoing determinists. Their philosophy will give them no stomach for it. They should not be blamed, for they actually have no free will. Nevertheless, their last state will be worse than their first.

But what of the people who react in opposition and set out to prove the author wrong? I have high hopes for some of those who found themselves called "educators" (complete with quotation marks). By way of protest they will work more actively than before for a better world. It will be purely a matter of stimulus and response—but what a response!

The now more ardent educators will work still harder and achieve greater influence. If they are really great educators with great messages they *will* succeed as never before in improving their civilization. What matters it if they preach free will when there is none? If they convince their hearers, these too will see no inconsistency in striving for a better world. Only through such endeavor will civilization actually improve, even in a deterministic world. The small results from some of the efforts at improvement which Professor White mentions are not evidence against the possibility of more marked improvements when the leavening agents are more powerful.

It seems to me, then, that to the extent to which people disbelieve in free will, the effect will be undesirable, and to the extent to which they believe, the effect will be good. The argument does not presuppose that there *is* free will. It assumes the opposite and examines simply the effect of a belief or disbelief in free will in a world in which there is actually none. It may be deduced, however, that the effects will be similar if there is actually freedom of will. The essence of the matter is that "faith inspires to effort, while doubt freezes the soul and paralyzes the arm. Men who do not believe do not achieve." Willard C. Selleck, who used these words in another connection, prefixed the word "intelligent." However, even though it may not be intelligent to believe in free will, the effect will still be good. If this be scientific heresy, let us make the most of it. We'd better!

I intend no disrespect to Professor White. He occupies what many regard as a very strong logical position. However, the complete denial of free will is one philosophical doctrine that does not seem to wear well in the world of practical affairs. Professor White has had the fortitude to venture out there with it, and he appears to have handled it consistently—a difficult task. Consistent application of out-and-out determinism in the world of man is deserving of some admiration, purely as a mental accomplishment. Sir James Jeans, who in spite of Professor White's quotation, admitted the force of the arguments against free will, wrote of the "characteristic irrationality" of the thoroughgoing determinist. Also, Esmé Wingfield-Stratford said that "if you turn out free will by the front door, there is nothing for it but to leave the back door quietly ajar, and let mum be the word."

It will have become evident that I believe that our wills do have some measure of freedom. Neither the argument from science nor the argument from pure logic seems to me to be profound enough to rule this out. I am encouraged by knowing that there are some eminent and highly accomplished scientists of like mind. But even in cases where close reasoning does seem to leave no loophole, it is well to remember that there have been logical paradoxes before now, some of which have been resolved in favor of the common-sense view. Zeno seemed to have an airtight case against the possibility of Achilles getting past the tortoise. I confess that the argument still fascinates me with its apparent conclusiveness. Nevertheless, it is evident, now, that Zeno got into a blind alley by adopting an approach that did not permit him to apply his reflections to a sufficient length of time. We have Bertrand Russell's word for it that the paradox is now completely resolved, with the race going to the swift, barring the contingencies of Ecclesiastes 9 : 11.

In subscribing to the freedom of the will, I place considerable confidence in what might be called "the argument from the existence of consciousness." Consciousness is a unique and most extraordinary manifestation, the very existence of which constitutes a striking anomaly in any deterministic world. As Arthur Compton says, "We find that among the higher animals the course of evolution has brought consciousness to an ever higher level of development. Why should this occur if consciousness were of no value to the life of the animal, and how could it be of value to the animal if it were incapable of affecting its course of action?"

HAROLD H. STEINOUR

Evanston, Illinois

TECHNOLOGICAL NOTES

Men and fish. Something about an island is cozy and snug. You know exactly what the limits of territory are, without choosing arbitrary boundaries. That definiteness of subject appears in a 140-page study called *South Bass Island and Islanders,* by Thomas Huxley Langlois and Marina Holmes Langlois. He is director of the Franz Theodore Stone Laboratory, of The Ohio State University, at Put-In-Bay, on South Bass Island in Lake Erie. She is Mrs. Langlois.

Dr. Langlois is a limnologist, and his professional interest is reflected in the approach to the social and economic relationships of the 273 human beings on the island. The Foreword is mostly quotation from a bulletin on the lives and habits of a colony of bass in a rearing pond where "The most desirable crop consists of the maximum number of individuals with the maximum mass weight." The parallel isn't exact; the way to prevent cannibalism in the fish is to provide plenty of food, and presumably lean years in the island economy would not lead the islanders to prey on each other.

Indeed, as the study shows, members of the human colony work together. This symbiosis produces a far higher return than the sum of individual efforts, no matter how energetic. The workings of the division of labor show up sharply in the various industries—real estate, wine, fishing, innkeeping, and transportation—and the union for protection is evident in the group decisions about education and religion, in the arrangements for sanitation and health, and in the organization for fire protection. For example, getting and keeping a doctor required community action when such behavior was unusual; since about 1880 the islanders have furnished an office-home for the physician. The post has its hardships; three of the sixteen doctors who have practiced on the island have drowned in Lake Erie.

South Bass Island was settled in 1811. Since then the industries have developed and fluctuated. Cutting and shipping ice had a boom at the time of the great ice famine in the early nineties, and then disappeared. Vineyards require the growing of a certain amount of rye, to tie up the vines. Fishing is not what it used to be, and hotel keeping, which flourished early in the present century, has now become largely a matter of catering to short-time visitors and furnishing an occasional meal to the summer residents, many of whom own their own cottages and have become part-time permanent islanders.

Sugared marble. We have all seen marble walls become dull and dark, a grievous disappointment in public monuments and buildings, but probably we have supposed that only the surface is spoiled. A study at the National Bureau of Standards indicates that the situation may be more serious. Weathering is not simply the effect of rain and acid fumes, freezing and thawing. When the dense tangle of calcite crystals—perhaps less than 1 percent voids—in a typical marble is heated, the crystals expand along one axis and contract in the other dimensions. On cooling the movement is reversed. The crystals cannot always return to their original positions, and the block tends to swell or grow. As much as 3.5 percent expansion has been observed. The solid block becomes a porous mass of sand. Marbles vary in their sugaring tendencies. When this property has been fully catalogued architects will have guidance for the selection of the right stone.

Hunger for copper. Battelle Memorial Institute, founded in 1929 at Columbus, Ohio, for cooperative research on metals and fuels, affords many examples of the ramifications of subjects and interests. Metals affect vegetation, so Battelle is engaged in agricultural research. A recent report from the Institute tells of the need for copper as one of the "micronutrients" in growing plants. Fertilizers enriched with copper sulfate improve soybeans, cotton, potatoes, and other vegetables noticeably, though the benefits haven't been definitely measured. Tobacco, in particular, responds to a copper ration by improvement up to 30 percent or more in quantity and quality.—M.W.

THE BROWNSTONE TOWER

FOR the past six years the first evidence of spring in Washington has been the appearance of a new crop of science talent in the persons of forty boys and girls, the winners of the annual Westinghouse Science Talent Search, administered by Science Service. This year I was able to attend all three evening events to which the older Washington scientists were invited. It was a rejuvenating experience to see and hear these splendid young people.

On February 29 I entered the building of Science Service to find a heterogeneous mixture of youth and age in the larger rooms. I say "heterogeneous" because the fortunate forty were not uniformly distributed among the larger number of older people who had come to meet them. They were attracted to the stars of the gathering. The largest number stood two deep around Dr. Lark-Horovitz, physicist and general secretary of the A.A.A.S. Another circle of boys enclosed Dr. Harlow Shapley, retiring president of the A.A.A.S., and a third group hemmed in Dr. L. B. Tuckerman, physicist of the Bureau of Standards. Dr. Tuckerman held the attention of his group by folding paper into geometrical figures. It was hard to find an unattached youngster, but I persisted until I had isolated a boy from Ohio and a girl from Long Island. The latter was from the Forest Hills High School, a student of Dr. Paul F. Brandwein, who last year described in the March SM the opportunities for scientific development provided in that school. She glowed at my mention of his name, and it was not hard to understand how her interest in research on *Planaria* had been kindled. But her story was not unique; the enthusiasm and encouragement of some teacher stood behind the accomplishments of every one of those boys and girls. I failed to find the students of Mr. Subarsky (Bronx High School of Science), whose article on the characteristics of science talent appears in this issue.

The next evening was reserved for showing documentary motion pictures at the U.S. National Museum. Pictorially, the best offering was a kodachrome film on the birds of the Bear River Wildlife Refuge, but in the question period following the showing of the pictures the young scientists asked so many questions about the reels on high-speed photography, solar prominences, and rockets that Dr. Shapley, who presided, feared the birds would be completely neglected. Certainly, physical science claims the interest of most of these young people.

The big banquet of the following evening was the final event of the most exciting five days in the lives of these young scientists. Here, after the speeches, they would learn the results of the scholarship competition among themselves. The fortunate forty were distributed throughout the huge ballroom, not more than one at a table seating ten people. Each was the center of attention at his own table. At our table was an attractive girl who looked so young and demure that it was hard to believe she had already graduated from high school and had entered a technical institute to study biophysics. She talked modestly about herself in response to questions. Her hero, I think, was Dr. Shapley, whose address from the speakers' table thrilled her. She did not win a principal Westinghouse Scholarship, but she already had a scholarship from the school of her choice. The final winners were congratulated while two television cameras were aimed at them, and at the end the great audience sang "The Star-Spangled Banner."

The boys and girls have gone home, taking glowing memories with them and a feeling of responsibility for the role they are expected to play in science of the future. Not for years, if ever, will they again receive the attention that was showered upon them here. A long road of hard study and strenuous work lies ahead before they can reach their first goals of service to science and humanity. But they will arrive, and perhaps one will gain the highest honor—the Nobel prize.

F. L. Campbell